63D CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 1001.

WABASH RIVER, IND. AND ILL.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORTS ON PRELIMINARY EXAMINATION AND SURVEY OF WABASH RIVER, IND. AND ILL., FROM ITS MOUTH TO TERRE HAUTE, WITH SPECIAL REPORT AS TO IMPROVING SAID RIVER UP TO MOUNT CARMEL BY DREDGING.

MAY 27, 1914.—Referred to the Committee on Rivers and Harbors and ordered to be printed, with illustrations.

WAR DEPARTMENT,
Washington, May 26, 1914.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers United States Army, dated May 25th instant, together with copy of a report from Capt. (now Maj.) Lytle Brown, Corps of Engineers, dated November 29, 1910, and copy of a report from Maj. J. C. Oakes, Corps of Engineers, dated March 10, 1914, with maps, upon a preliminary examination and survey, respectively, of Wabash River, Ind. and Ill., made by them in compliance with the provisions of the river and harbor act approved June 25, 1910.

Very respectfully,

LINDLEY M. GARRISON,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, May 25, 1914.

From: The Chief of Engineers, United States Army.
To: The Secretary of War.
Subject: Report on preliminary examination and survey of Wabash River, Ind. and Ill.

1. There are submitted herewith for transmission to Congress report dated November 29, 1910, by Capt. (now Maj.) Lytle Brown, Corps of Engineers, and report dated March 10, 1914, with maps, by

Maj. J. C. Oakes, Corps of Engineers, on preliminary examination and survey, respectively, authorized by the following item contained in the river and harbor act approved June 25, 1910:

Wabash River, from its mouth to Terre Haute, with special report as to improving said river up to Mount Carmel by dredging.

2. The improvement of the Wabash River by the United States was begun in 1872, and subsequent to 1881 was prosecuted under two projects, one providing for work above Vincennes and the other for work below that place. The work done consisted in open-channel improvement, the removal of obstructions, and the construction of a lock and dam at Grand Rapids, Ind. Appropriations for the improvement of the Wabash ceased in 1902, and since that date work has been confined to the operation and care of the lock and dam, under allotments from the permanent indefinite appropriation for operating and care of canals and other works of navigation. In the report on survey the district officer discusses the various methods of possible improvement and their applicability to the case in hand. Canalization of the stream is considered the only means of improvement which will be certain to provide a definite navigable depth much in excess of the natural low-water depth. He submits two plans for such an improvement, one providing for 19 locks with fixed dams, and the other for 12 locks with movable dams and 2 locks with fixed dams, the depth proposed in each case being 6 feet. He prefers the movable dams as causing less overflow damage and as offering less obstruction to navigation and estimates that such a system can be installed at the present time for $8,000,000, with annual operating cost of approximately $205,000. The cost of maintaining the structures would vary with the age of the system, damage by floods, etc., and no estimate therefor is given. Snagging would be necessary in connection with any method of improvement, for which a boat would be required at an estimated cost of $40,000, with $15,000 annually for operation and maintenance. Improvement below Mount Carmel by dredging alone is considered impracticable.

3. The district officer recognizes the importance of the developed and undeveloped resources of the country tributary to the Wabash River, but for reasons fully explained believes that but little commerce would follow the improved waterway, and that the cost of the proposed improvement is greater than is warranted at the present time. The division engineer agrees in general with the views of the district officer and concurs with his conclusion that it is not advisable for the United States to undertake any further improvement of the Wabash River at this time.

4. These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its report herewith, dated May 6, 1914, concurring with the views of the district officer and division engineer.

5. After due consideration of the above-mentioned reports, I concur with the views of the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore report that the improvement by the United States of Wabash River from its mouth to Terre Haute, or to Mount Carmel, is not deemed advisable at the present time.

DAN C. KINGMAN,
Chief of Engineers, United States Army.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS ON SURVEY.

[Third indorsement.]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
May 6, 1914.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. This report covers preliminary examination and survey of Wabash River from its mouth to Terre Haute, with special report as to improving said river up to Mount Carmel by dredging, called for by the act of June 25, 1910.

2. The district officer describes the work that has been done, including the construction of a lock and dam near Mount Carmel. No appropriations for improvement have been made since 1902, and no work has been done since then except that connected with the maintenance and operation of the lock and dam. The total expenditures to June 30, 1913, have been $892,545.02. Of the work done, nothing remains except the lock and dam at Grand Rapids and a number of cuts through rock bars.

3. The distance from Terre Haute to the mouth is 214.4 miles. The fall is 132 feet, an average of 0.615 foot per mile, the maximum being 5.3 feet in a distance of less than 2,000 feet at the New Harmony cut-off. The banks of the stream are low and generally of material easily eroded. Altogether there are 68 miles of caving banks. The estimated low-water discharge at Terre Haute is 1,890 second-feet and at the mouth 2,500 second-feet, while at the bank-full stage at these places it is, respectively, 43,700 and 85,000 second-feet. The maximum discharge at Mount Carmel is estimated at 385,000 second-feet. The difference between the bank-full stage and the figures just given represents the amount of overflow, which at flood reaches a height of about 11 feet above the general bank level, and at times the stream is 7 miles wide. Overflows occur two or three times each year.

4. If the river is improved, it should be with a view to accommodating such boats as operate on the tributaries of the Ohio, and for these a depth of at least 6 feet should be given. The estimates have been based upon this depth. The various methods of improvement are discussed by the district officer, including reservoirs, snagging, dredging, regulation, and canalization, and he concludes that the latter method should be adopted if the improvement is to be undertaken. He discusses and submits estimates for both fixed and movable dams, the latter, for reasons given, being preferred.

5. The first plan calls for 19 locks and dams, including the existing one at Grand Rapids, the cost in round numbers being $8,400,000. The second plan would require 14 locks and dams, would utilize the present fixed dam at Grand Rapids, and provide for one other fixed dam on the lower portion of the river, the balance being movable. The estimated cost in round numbers is $7,900,000, or approximately $8.000.000 for either plan, with an annual operating cost of about $65,000 for the fixed type of dams, and $205,000 for the movable type.

6. The Wabash country is well supplied with railroads running east and west and north and south. The territory immediately adjacent to the river is agricultural, and no great tonnage could be expected from this source. Large areas, at not great distances from the river, are underlaid by coal, but the district officer does not

believe that much of this commodity would move south. The Pittsburgh and Alabama districts now largely supply the lower Mississippi Valley and the southern ports, and in view of recent improvements in transportation both by rail and water from the Alabama district the district officer believes that the Gulf cities will be largely supplied from that section. He believes that, generally, the manufactured products of the Wabash country will be shipped north, east, and west and only a small proportion south. A study of conditions, physical and commercial, leads him to the conclusion that the Wabash River is at the present time unworthy of being improved by the United States either from its mouth to Terre Haute or to Mount Carmel. In this view the division engineer concurs.

7. Interested parties were informed of the unfavorable report of the district officer and given an opportunity of submitting their views to the board. A compilation of commercial statistics by the Terre Haute Chamber of Commerce, forwarded by Hon. Ralph W. Moss, M. C., has been received and given consideration.

8. The results of the survey indicate that the only practicable method of improving the Wabash River between its mouth and Terre Haute that would result in a continuous and useful navigation would be by locks and movable dams, which are estimated to cost about $8,000,000 for first construction and $205,000 a year thereafter for operation. Such canalization would interfere to some extent with drainage of the low grounds, a matter of prime importance in this valley.

9. Terre Haute is an important manufacturing center now, having an extensive commerce. This would be the principal locality to be affected by the desired improvment, although there should be some traffic in farm produce and some in coal. The coal fields are not immediately adjacent to the river and connection therewith by rail would have to be made. The amount of commerce that would develop is purely conjectural, and while there are many who seem to believe that it would be large, it is the opinion of the board that it would not be sufficient to warrant the very large cost of the improvement. It therefore concurs with the views of the district officer and the division engineer and reports that in its opinion it is not advisable at this time for the United States to undertake the improvement of the Wabash River from its mouth to Terre Haute or to Mount Carmel.

10. In compliance with law, the board reports that there are no questions of terminal facilities, water power, or other subjects which could be coordinated with the project proposed in such manner as to render the improvement advisable in the interests of commerce and navigation.

For the board:

W. M. Black,
Colonel, Corps of Engineers,
Senior Member of the Board.

PRELIMINARY EXAMINATION OF WABASH RIVER, IND. AND ILL.

United States Engineer Office,
Louisville, Ky., November 29, 1910.

Sir: The river and harbor act approved June 25, 1910, provided for an examination of Wabash River from its mouth to Terre Haute,

with special report as to improving said river up to Mount Carmel by dredging.

The duty of making this examination was assigned to me by a letter from your office dated August 4, 1910, and I have the honor to submit the following report thereon.

FORMER EXAMINATIONS.

1. The first examination of the river was made in 1871 and since that date a number of examinations together with a detailed survey of the river between its mouth and Terre Haute, Ind., have been made. (See Annual Reports of the Chief of Engineers, United States Army as follows: 1871, p. 487; 1872, p. 472; 1875, p. 739; 1876, p. 58; 1878, p. 837; 1879, p. 1447; 1880, p. 1840; 1881, p. 1998; 1882, p. 1973; 1883, p. 1583; 1884, p. 1759; 1885, p. 1649; 1891, p. 2411; 1904, p. 2726 and p. 2729.) The last reference is to the report of a detailed survey from the mouth of the river to Vincennes, Ind., and an accompanying project and estimate of improvement based on the said survey.

PHYSICAL CHARACTERISTICS OF THE STREAM.

2. The Wabash River has its sources in northeastern Indiana and western Ohio, flows across the former State in a generally southwesterly direction to the boundary between Indiana and Illinois at a point some 10 miles south of Terre Haute, Ind., and thence south between those two States into the Ohio River at a point 838 miles from Pittsburgh, Pa. The country which it drains is generally level and its drainage area is about 25,000 square miles. The soil adjacent to the stream, so far as has been examined, is a light sandy loam underlain by shale or sandstone and coal.

3. The principal tributary on the east bank is White River, a considerable stream entering the main river 93 miles from its mouth; and on the west side the Little Wabash, a small river, enters the main stream at a distance of 14 miles from the Ohio.

4. The portion of the river under examination—from its mouth to Terre Haute, Ind., has a channel length of 215 miles, and to this portion only is attention especially invited.

5. The variation in water surface at the mouth is governed by the Ohio and is about 50 feet, at Mount Carmel 93 miles from the mouth it is 28 feet, and at Vincennes 125 miles, 23 feet, and at Terre Haute 215 miles from the mouth, 29 feet. The gauge read at Mount Carmel daily since 1899 shows that in an average year there are 132 days when there is at least a 5-foot stage above low water or at least 6 feet over all bars between the mouth and Terre Haute.

6. Very few measurements of discharge have been made. The indications are that at a stage of 0.36 foot above low water at Vincennes the discharge at that place is 2,965 cubic feet per second, and and at a stage of 1 foot at Mount Carmel, just below the mouth of White River the discharge is 8,316 cubic feet per second. These measurements were hurriedly made with rod floats, they show a surprisingly large discharge and are not regarded as of much value.

7. The average slope of the low-water surface between the mouth and Mount Carmel is 0.63 foot per mile, between Mount Carmel and Vincennes it is 0.75 foot per mile, and between Vincennes and Terre Haute it is 0.55 foot per mile.

8. The obstructions to navigation are sand and gravel bars, rock ledges, and snags. The vital points of information concerning all bars whose prominence at low water reduces the depth to less than 4 feet are given in the table in paragraph 11. The river is comparatively free from snags between Vincennes and the mouth, but is badly obstructed by them between Terre Haute and Vincennes.

9. The most striking feature of the stream affecting its improvement for navigation is the unstable nature of its banks and bed. The banks are invariably of a light sandy loam, with occasionally a little clay. They are also low, rarely rising over 15 feet in height above low water. It is only on straight reaches or in bends of slight curvature that the banks are not cutting badly. This feature of the banks, together with the moderate slope, accounts for the extreme width of the stream. Out of the 215 miles between the mouth and Terre Haute there are about 70 miles of cutting banks. The point side opposite nearly every bend consists of a wide, shelving, low sand bar, making out constantly as the opposite bank cuts away. The bed of the stream where rock does not exist is composed of sand, grading in coarseness from fine sand to small gravel, depending on the slope or velocity of the current. In the reach between Terre Haute and Vincennes, the soft banks and the channels being choked with snags, are responsible for the cut-offs that have been made and will be made in the future. Nearly all banks are overflowed in flood time and between Terre Haute and Mount Carmel there is extensive levee work on both banks, while between Mount Carmel and New Harmony a system of levees on the Indiana side is projected by private enterprise to be continuous between the latter place and Patoka Creek, in all about 80 miles. On the river below New Harmony the influence of the Ohio rises is so great as to render levee work a very serious undertaking and no levees are to be found adjacent to the river; likewise few building sites for houses or barns exist near the river, such as do exist being on mounds or high underpinning.

10. Since the survey between Vincennes and Terre Haute (1879) complete cut-offs have been made at Hackberry Bend and Horseshoe Bend, and since the survey between Vincennes and the mouth (1903) a small bend has been cut out just above Nine Mile Island, 8 miles below Vincennes. While changes have been constantly in progress since the surveys were made, these surveys still represent the general regimen of the river, and the data given in paragraph 11 are based on former surveys.

11. The following table shows in concise form the location and character of what may be regarded as the principal obstructions in the river in the distance considered. Any bar at which the depth is less than 4 feet at low water is regarded as an obstruction which would require measures for improvement. It may be noted that the major obstruction is the New Harmony Cut-off, not from lack of depth, but for the reason that its fall makes it a rapids over a rough rock bottom. At low water this place is an absolute bar to all navigation. Other points that may be regarded as second in importance are Grand Chain, Little Chain, White River bar, and the bar 117 miles from the mouth. At all of these points the presence of rock bottom close to the surface causes trouble. It is evident from inspecting the locality that the fall over White River bar as obtained from the survey is incorrect. In the table—

Column A is the distance in miles from the mouth.
Column B is the depth in feet on the crest of the bar.
Column C is the length of the bar on which the depth is less than 4 feet.
Column D is the nature of the bottom; S.= sand, G.= gravel, R.= rock.
Column E is the width of the river at low water.
Column F is the width of the channel whose depth is 4 feet or more.
Column G is the slope in feet per mile over the obstruction.
Column H is the name of the locality.

A	B	C	D	E	F	G	H
Distance.	Depth on crest.	Distance between 4-foot contour.	Bottom.	Width.	Width 4-foot contour.	Feet per mile slope.	Name of locality.
3.7	3.7	750	S. & G.	1,185	200	1.60	Skidmore bar.
7.5	3.5	270	S. & G.	1,100	125	.88	Mackeys bar.
11.7	2.7	1,650	S. & G.	1,130	150	.71	Raglan Island.
24.5	2.8	1,240	R.	820	100	3.40	Little Chain.
27.5	3.3	1,300	S.	1,040	250	.77	Big Creek.
30.5	3.0	2,350	R.	770	250	6.50	Grand Chain.
40.4	5.2	.....	R.	600	.....	10.10	New Harmony Cut-off.
58.5	3.8	700	S.	1,120	100	1.00	Fox River.
59.2	3.4	1,200	S.	1,140	200	1.20	
76.0	3.2	1,230	S.	1,100	100	1.40	
87.5	2.5	3,250	R.	1,250	100	1.60	Coffee Island.
89.0	3.7	230	G.	1,140	100	.30	Schroats bar.
93.5	.7	2,000	R.	1,020	150	.70	White River bar.[1]
104.0	3.1	2,100	R.	900	100	.77	
108.0	2.9	1,100	R.	800	75	.85	
108.25	3.7	800	R.	820	60	1.10	
112.0	3.8	470	G.	670	75	.40	
117.0	3.3	1,050	R.	600	100	1.20	
121.5	3.4	1,800	S. & G.	670	75	1.00	
126.0	3.0	2,400	S. & G.	650	100	.90	
128.0	2.1	2,600	S. & G.	730	200	.90	
129.0	3.5	600	S. & G.	700	150	.70	
131.0	2.3	700	S. & G.	600	150	.90	
134.5	2.3	1,900	G.	720	200	1.60	Belgrade bar.
136.5	2.2	650	G.	700	100	1.80	
138.0	3.1	400	G.	560	150	1.00	
139.0	2.6	1,300	G.	600	100	1.30	Russellville bar.
140.0	3.1	1,300	G.	650	75	.60	
141.0	3.7	800	G.	580	100	1.40	Goose bar.
142.0	3.1	1,400	G.	670	200	1.10	Swan Island.
146.0	2.8	350	G.	500	200	1.30	Johnsons Ripple.
159.0	2.2	500	G.	500	60	1.40	
161.0	2.6	700	G.	500	100	1.90	Greers Ripple.
162.5	2.6	2,000	S. & G.	650	150	1.10	Eagle Island.
163.2	2.2	1,200	S. & G.	500	75	1.50	Do.
170.1	2.8	5,100	S. & G.	600	100	1.10	
177.5	2.5	340	S.	550	75	.50	Greens Ripple.
180.0	2.9	1,300	S. & G.	560	100	2.60	Devils Island.
180.8	2.5	600	S.	570	75	.80	
185.5	3.7	400	S.	650	75	2.00	Prairie Creek.
186.5	2.6	900	G.	650	60	.25	Chenoweths reach.
190.0	3.2	400	G.	440	50	3.10	Bowens Ripples.
192.5	3.3	400	S.	620	100	.60	Darwin.
194.5	2.1	1,100	G.	420	75	2.80	Aurora Ripple.
195.8	2.3	1,100	S. & G.	600	75	1.60	
196.3	3.3	700	G.	500	150	.40	Turkey reach.
197.5	2.2	4,100	G.	650	100	1.20	
199.5	2.5	1,100	G.	400	75	3.80	Strains Ripple.
201.0	3.1	400	G.	500	60	.70	Raymonds Ripple.
201.25	2.6	1,200	G.	700	200	1.70	
202.25	1.5	400	S. & G.	580	150	.20	
203.0	2.2	800	S. & G.	680	100	.40	Goose Nest Island.
205.0	2.4	4,800	S. & G.	600	200	.30	
207.5	2.3	900	S. & G.	350	100	1.70	Nine Mile Islands.
208.8	2.4	1,100	G.	400	150	3.20	Musgraves Ripple.
210.8	2.0	700	S. & G.	500	150	.80	
214.5	2.7	4,800	S. & G.	320	75	1.20	

[1] Data for slope apparently wrong.

RESOURCES OF THE WABASH VALLEY.

12. In general it may be said that the territory to be considered is embraced in the counties of Gallatin, White, Wabash, Lawrence, Crawford, and Clark of Illinois, and Posey, Gibson, Knox, Sullivan, and Vigo of Indiana. This territory is one of the richest agriculturally in the Ohio River Basin; its annual production at present in four staple farm products is:

Corn	bushels	15,700,000
Wheat	do	5,250,000
Oats	do	4,000,000
Hay	tons	350,000

13. The population of the territory is about 400,000.

14. The counties of Sullivan, Vigo, Knox, and Gibson, of Indiana, produced in 1907 6,000,000 tons of coal, of which about 50 per cent was distributed outside of the State by rail. The production of coal in the State of Indiana in 1901 was 6,000,000 tons and in 1907 was 12,000,000 tons. All of the counties named in Indiana are underlain with coal. While coal exists in the Illinois counties named it has not been worked, its depth exceeding that which has been developed in other localities. White and Gallatin Counties produced 80,000 tons of coal in 1909. The Illinois oil field lies largely in the counties of Clark, Crawford, and Lawrence and is actively productive.

15. The manufacturing industries of the valley center at Terre Haute and to some extent at Vincennes. They are of considerable importance and consist principally of clay products, glass, hominy, malt and spirituous liquors, and machinery. (See letter from Commercial Club of Terre Haute.) It may be said that Terre Haute is a center of industry which is destined to grow into prime importance, as its shale beds are vast in extent and coal is at hand, while it already has excellent railroad facilities. The American Car & Foundry Co. there employs 1,500 hands, while the Vandalia Railroad is erecting shops and terminal facilities estimated to cost $3,000,000 and to give employment to 3,000 men.

16. The principal towns on the river are: Terre Haute, population, 58,000; Darwin, 250; Hutsonville, 1,000; Russellville, 260; Vincennes, 16,000; St. Francisville, 600; Mount Carmel, 4,311; Grayville, 2,000; New Harmony, 1,341; Maunie, 600.

17. The railroad system of the valley on east and west lines is very complete. The Louisville & Nashville line from Evansville to St. Louis crosses at Maunie, 30 miles from the mouth. At Grayville, 62 miles from the mouth, a branch of the Illinois Central from Evansville to Chicago crosses. At Mount Carmel, 93 miles from the mouth, the Southern, from Louisville to St. Louis, crosses. At a point 89 miles from the mouth the Cleveland, Cincinnati, Chicago & St. Louis is building a crossing for its line from Evansville to Chicago via Danville. At 117 miles from the mouth a branch of the Illinois Central, Indianapolis west, crosses. At Vincennes the main line of the Baltimore & Ohio, Cincinnati to St. Louis, crosses. At Terre Haute the Vandalia, Indianapolis to St. Louis; the Cleveland, Cincinnati, Chicago & St. Louis, Cincinnati to St. Louis; and a branch of the Pennsylvania from Terre Haute to Peoria, cross. The river is closely paralleled only from Vincennes to Grayville, this by the Cleveland, Cincinnati, Chicago & St. Louis.

PRESENT AND PROSPECTIVE COMMERCE.

18. No statistics of the present commerce are available save for the passage of the United States lock at Grand Rapids near Mount Carmel. It is known that considerable grain is moved by boat from the river bottoms in the spring, but such movement is irregular and no records of it can be obtained. In the low stages of the river there is practically no commerce by river. In the period 1878–1887, when work of improvement was in progress on the river, commercial statistics showed that the commerce exceeded 100,000 tons per annum, of which grain at times exceeded 75,000 tons. Accurate statistics are kept at the lock at Grand Rapids and show that the tonnage passing the lock has been—

1896	3,252	1903	2,030
1897	3,749	1904	4,370
1898	1,652	1905	8,025
1899	2,417	1906	3,990
1900	6,419	1907	6,600
1901	1,128	1908	5,156
1902	1,278		

These records at the lock are of no value as an indication of commerce, since the lock is isolated by obstructions both at the head of the pool and immediately below the lock.

19. No definite estimate, or even assumption, can be made of the prospective commerce, except that in the present state of the stream it is destined to amount to little or nothing. Were the stream improved for a 6-foot navigation all the year from its mouth to Terre Haute, it would doubtless develop a commerce considerable in extent. Two hundred thousand tons of grain annually might well find river transport, and a considerable quantity of the manufactured products of the Terre Haute district destined for southern and southeastern markets might be shipped by river. It does not seem unreasonable to assume that the total tonnage would exceed 500,000 tons annually. Should the coal find a southern market, of which there is not much prospect as long as the Pittsburgh coal goes south, the figures given above would doubtless be very greatly increased. The timber industry, which goes to swell tonnage on some streams, does not exist on the Wabash.

TERMINAL FACILITIES.

20. As no systematic traffic exists on the stream there are at present no terminal facilities, but the ease of providing the same, because of the relatively low banks, is marked. On the lower river the corn destined for river shipment is stored in cribs on the river bank. Should there ever be a prospect of transshipment from rail to river or river to rail facilities for such should easily be provided, as at most of the places on the river having rail transportation spurs exist to the top of the bank.

21. Terre Haute owns no land that might be used as a public landing, but about 1,000 feet of river front is available. Vincennes owns some 1,200 feet of river front and a like amount is owned by the municipality of Mount Carmel.

WATER POWER.

22. It is not believed that any scheme of improvement for purposes of navigation will develop water power that will be of commercial value. The dam at Grand Rapids produces more power than would any similar one that might be built. Although this dam is within 3 miles of the town of Mount Carmel no use has been made of this power which has been available for 14 years.

IMPROVEMENT FROM THE MOUTH TO MOUNT CARMEL BY DREDGING.

23. Attention is invited to the nature of the various obstructions in the stream in the 93 miles from the mouth to Mount Carmel, as given in paragraph 11, also to the physical characteristics of the stream as described in paragraph 9. In the reach considered there are rock bars at Little Chain, Grand Chain, Warwicks Ripple, Coffee Island, and in the cut-off at New Harmony, which for a channel 100 feet wide and 6 feet deep at low water would require rock excavation of about 80,000 cubic yards; there are also soft bars which for a channel 150 feet wide and 6 feet deep at low water would require about 3,250,000 cubic yards of dredging. The corresponding quantities for a channel 4 feet deep at low water would be rock excavation 22,500 cubic yards, sand and gravel excavation 1,200,000 cubic yards.

24. No dredging has been done on the Wabash River which can be taken for a guide now. Rock excavation has been done at the localities mentioned and some of the rock was taken out by dredging. The results of this excavation were not such as to be of much benefit, the channels being very restricted and the current velocities in them at low water being such that boats could scarcely stem them and could be handled with difficulty in descending. At one time (1878) two dipper dredges were sent into the Wabash from the Ohio, but no serious work was accomplished; the most arduous work seemed to be the getting of the dredges through the Grand Chain rock excavated channel (see Report of Chief of Engineers, 1878, p. 834). When the dredges arrived at the bar for work, it was reported that the material could scarcely be kept in the scows on account of its fineness. The assistant engineer in charge of the outfit reported: "An examination of the other bars where dredging was proposed showed that all were composed of sand, and as but little good would have resulted from dredging where the bottom is so light and easily moved, this part of the work was abandoned." The material of the bars is not so light as this report indicates; it is light in comparison with that of the bars of the upper Ohio in that the larger portion of it is sand and fine gravel. A dipper dredge with 1-yard bucket was at one time in service on the Wabash; no record of its performances can be found, and would be of little value at this time. It seems to have been used in removing disrupted rock from the channel blasted through Little Chain. It would be very desirable to have the results following a thorough dredging of one of the soft bars of the Wabash; no record of such work exists. The results of the work that has been done in cutting through the rock bars at the various localities may be given as follows:

Little Chain.—In 1883 a channel 35 feet wide was excavated through the bar, and rock-filled wooden crib dikes were built on each side of the excavated channel. The dikes have disappeared. The current in the cut was such as to make it difficult for boats to ascend and dangerous for a tow to descend. The channel is too restricted in width, and its depth of 2.8 feet at low water is inadequate. The work probably ameliorated the very bad condition at Little Chain, but fell far short of providing safe and ample facilities for navigation.

Grand Chain.—In 1873–1881 a channel 100 feet wide was excavated through the bar, and rock-filled wooden crib dikes were built on each side of the cut. At present the dikes have almost disappeared, and the depth at low water is 3 feet. The current velocity in this channel is about 7 feet per second at low water, and navigation is very difficult upstream and dangerous downstream. The work was doubtless of some benefit when done, but has been inadequate in providing the proper facilities for navigation over the obstruction.

Warwicks Ripple.—In 1880 a cut was made through this bar 100 feet wide. This cut has been successful in giving 3 feet of water through the obstruction and a current not excessive at low water.

Coffee Island Chute.—In 1879 a channel 3 feet deep and 100 feet wide was cut through the bar in the narrow chute at this island. The present depth is 2.5 at low water, and the current is too swift for safe navigation in so restricted a channel. Confining dikes of stone at the head and foot of the island were built. These have all but disappeared.

From an examination of this work in the field and a study of existing maps and the very meager discharge observations at hand, I am of the opinion that satisfactory results can not be obtained by simply excavating channels through the rock bars at Little Chain and Grand Chain. The fall is such that to secure suitable velocities at low water in any excavated channel of reasonable dimensions very extensive works of contraction and bottom protection will be required below each of these localities. These works would be low dams of brush, pile, and rock construction and would require constant repair and close supervision; and finally they may not give adequate results.

New Harmony Cut-Off.—When this cut-off was made rock was bared in the bottom at such elevation that the slope in the new river could not assume the average slope of the river, and the result is that almost the entire low-water discharge plunges over a rough, steep rock bottom, with most of the fall concentrated at one point. The old river bed is nearly filled in with a deposit of sand, gravel, and snags. A dam was built in 1876–1879 across this cut-off with a view of forcing the river around through the old channel. This dam was left inland by the river cutting around its island end. Now there is a rapids in the cut-off and no channel in the old river. Navigation can not pass New Harmony, 40 miles from the mouth, except when the river is at stages some 5 or 6 feet above low water. The fall in the cut-off is such that the excavation of a channel through the rock seems beyond reason. The best method of improvement by dredging would be to build another dam across the cut-off and dredge in the old channel. A dam across the cut-off is practicable, but would require much protection to save it from the fate of the old dam, as the banks of the island are quite low and soft.

25. As has been noted above, there are no records which show the effect of dredging on the soft bars of the Wabash. It may be assumed that, if a properly located channel were cut through such a bar, the low-water discharge is ample to keep it open, and that as a rule the slope is not so steep as to cause a serious lowering of the water surface on the next bar above. It may also be reasonably assumed that the material of the bars and banks is so fine and easily eroded that the dredged channel of one season would be obliterated at the next season of flood, provided, of course, that nothing was done to hold the banks in the cutting bends and to give some contraction by works over the worst bars. Dredging by dipper dredges and the transportation of the dredged material in scows is scarcely possible on account of the distance that it would be necessary to go to secure suitable dumping grounds. For the economical handling and advantageous placing of the material of these bars, a suction dredge and pipe line would be indispensable. One such dredge of a capacity of 3,000 cubic yards per day would meet the requirements if works of regulation were carried on in conjunction; if they were not, then two or three such dredges could scarcely cope successfully with all of the soft bars in the reach considered in one low-water season.

26. No record of the present commerce on the river between its mouth and Mount Carmel exists or can be obtained. The principal freight carried out of this section of the river is grain, and this is done by special trips of steamers and barges at periods of high water. For purposes of considering the improvement of the stream, prospective commerce, based on the productiveness of the country, must be the basis, as no organized river traffic exists or is possible at the present time. If the final object of any plan of improvement were to carry navigation as far as Mount Carmel and no farther, I feel that the expense of a thorough system of improvement would fall much short of being justified. It is the section of the river between Mount Carmel and Terre Haute that will possibly furnish most of the freight outside of agricultural products and will cause freight to move both ways on the river.

As to the improvement of the river between its mouth and Mount Carmel by dredging alone, that is impracticable; by dredging combined with other methods it may be practicable at a cost that will not prove excessive.

SUGGESTED METHOD OF IMPROVEMENT.

27. The agricultural value of the valley of the Wabash, especially that part of the valley below Mount Carmel, is immense, and the land seems to be inexhaustible as crop after crop of corn has been planted for 50 or 60 years. The banks are generally low and the ground in the immediate lowlands is subject to flood in springtime, but rarely in summer. The bottoms are wide. Water over the banks, or perhaps near the top of the immediate banks, floods much land. A flush rise in the summer after the crops are in requires only a little exaggeration to cause great damage and is always a source of anxiety. To prevent such rises from doing harm much work has been done on levees, and much more is in prospect by private organizations. It follows from these considerations that any system of works for navigation on the Wabash, in the portion

under consideration, must be free from any tendency to exaggerate a rise in summer. A system of fixed dams on the river would tend to exaggerate rises, and whether they did so or not would be open to the accusation and would receive it, this even though they were of low lift. For this reason I would dismiss the consideration of fixed dams in any plan of improvement.

28. The river, as a rule, has banks that are very easily eroded, and a bottom, save at certain localities, which is composed of sand and fine gravel of unknown depth. The founding of any heavy masonry structures will be expensive, unless they are placed at particular localities where rock exists. The concentration of fall at any locality will require bank protection there and for some distance below. In general, the features of the bed and banks are not suitable for works of canalization, and least of all for those works which greatly concentrate the energy of the stream. Therefore, the fewer of such structures the better.

29. There are some localities where rock bars cut across the channel and over these bars the fall is excessive—too great, in my opinion, to be reduced with economy and certainty by any means, either by simple excavation or by a combination of excavation and a raising of the slope below the excavation. At such places the structures for canalization can be economically and safely founded. These places are, specifically, Little Chain, 27 miles from the mouth (this includes Grand Chain, 3 miles upstream), New Harmony cut-off, 40 miles, Coffee Island, 87 miles (this includes White River Bar, 6 miles upstream), and Pork Island Bar, 117 miles from the mouth.

30. The slope of the river except at the places of rock bars is low and fairly uniform, the discharge is considerable, and the bed and banks are easily moved. The energy of the stream seems sufficient to maintain an adequate channel when properly directed and controlled.

31. The proper method of improving the stream seems to be by movable dams, where dams can not well be avoided, and by regulation supplemented by dredging in all other localities.

32. It does not seem desirable to go into detail as to the particular types of structures that would be most desirable for movable dams. In providing pools for navigation, and from expense of construction and maintenance they are not as desirable as fixed dams, nor would they have any advocates among those who are looking for water power in conjunction with works of river improvement. They are suggested in this case mainly for the reasons set forth in paragraphs 27 and 28. But for towboat navigation at open river stages they do have some advantage and possess some advantage in economy of lock construction. In conjunction with regulation they may be of some use in prolonging what may be found to be the stage of maximum bar cutting; this, however, is highly improbable, as it will not be desirable to throw the dams when their pools are necessary for navigation. As a suggestion, I would say make the dams as follows: A navigable pass of regulation Chanoine wickets, say, for a length of 400 feet, a regulating weir of Boulé frames for a length of about 400 feet, and the balance, say 400 feet, of fixed weir. The Chanoine type has been thoroughly tried at a number of places on the Ohio and the Boulé type at one point on that stream.

33. The practicability of maintaining a depth of 6 feet at low water by works of regulation alone is difficult of determination even with full data, and quite impossible at present. But if the low water discharge is as large as a rough measurement has indicated (par. 6), it seems reasonable to believe that this depth can be obtained, or, if not, then the additional dredging will not be great. This is my belief from an examination of the stream itself and from a study of the map. The depth in nearly all bends where the water has been held to the concave bank is over 6 feet and in cases 18 or 20 at low water. The river everywhere is of excessive width, 1,200 feet in the lower reaches, and 600 in the upper; there is abundant room for contraction at the crossings, and it is reasonable to suppose that a moderate amount of contraction will produce the desired depths.

34. The general method of regulation would be to hold all sharp concave (cutting) bends by brush revetment and to contract the low-water channel by wing dams of pile, brush work, and stone, all of the materials for such work being available. There are a few minor channels which would naturally be closed by brush and pile dams.

35. The subject of bank protection, the holding of the banks in position, is intimately connected with the work of levees. Outside of the interests of navigation, the work of improving the river by the method of regulation will be the first step toward the systematic levee work of the valley, thus tending toward a general benefit to adjacent farm land rather than its injury.

36. The present information in regard to the river is not sufficient for the preparation of suitable plans for its improvement by any method. The topography of the last survey extends only to the top of the immediate banks, and does not show what land would be flooded by the creation of pools by dams. The system of levels is not reliable and should be rerun, and special observations for slope should be made at stages at and above low water. Complete discharge observations should be made. In cases of possible locations for locks and dams, a thorough investigation of each site as to banks, foundation conditions, etc., will be necessary before the practicability or cost of such structures can be ascertained. Borings should be made on all bars where dredging is probable.

CONCLUSION.

37. The complete improvement of the Ohio River from its source to its mouth, providing for a navigable depth of 9 feet and to be completed in 12 years, has been directed. In order that this trunk line shall have its full amount of freight each important tributary should contribute its proper quota. Every important tributary of the Ohio, save the Wabash, has been provided with facilities for navigation more or less complete. At present navigation on the Wabash is impracticable because of serious obstructions within 50 miles of its mouth, and there is little or no commerce on the stream. But in point of length and volume of discharge the stream is one of the first in importance among the tributaries, and as to the natural resources of the valley, it is perhaps second only to the Monongahela. Since from the fact that traffic on the stream at present is impracticable,

very little commerce exists, and the worthiness of the stream as a line of transportation must be based on the resources of the immediate country through which it passes and on the cost of making it a reliable carrier of freight. I believe that the stream is worthy of careful and serious consideration in order to determine whether or not its permanent improvement is practicable within reasonable cost.

RECOMMENDATION.

38. I recommend that the sum of $25,000 be allotted for a survey to secure all the necessary information mentioned in paragraph 36 and for the preparation in detail of a project for the improvement of the Wabash River from its mouth to Terre Haute, Ind.

Appendixes: Letter requesting information. Letters from Commercial Club of Terre Haute, and letters furnished by Commercial Club of Terre Haute. Letter from mayor of Vincennes (extract).

Map 1 inch to 1,000 feet, Terre Haute to Vincennes.[1]
Map 3 inches to 1 mile, Vincennes to mouth (4 sheets).[1]
Map 1 inch to 200 feet, locality of Little Chain.[1]
May 1 inch to 200 feet, locality of Grand Chain.[1]
Map 1 inch to 200 feet, locality New Harmony Cut-Off.[1]
Map 1 inch to 200 feet, locality of Coffee Island Chute.[1]
Map 1 inch to 200 feet, locality White River Bar.[1]
Map 1 inch to 200 feet, locality of Nine-Mile, or Pork, Island.[1]

Respectfully submitted.

LYTLE BROWN,
Captain, Corps of Engineers.

The CHIEF OF ENGINEERS, UNITED STATES ARMY
(Through the Division Engineer).

[First indorsement.]

WAR DEPARTMENT,
OFFICE OF THE DIVISION ENGINEER, CENTRAL DIVISION,
Pittsburgh, Pa., December 8, 1910.

1. Respectfully forwarded to the Chief of Engineers, United States Army.

2. The Wabash enters the Ohio River about 840 miles below Pittsburgh, within the limits of proposed pool No. 50. As the general scheme for the improvement of the Ohio contemplates building the dams on the upper Ohio first, it will probably be several years before there is slackwater at the mouth of the Wabash River.

3. Neither the present nor immediately prospective commerce would seem to warrant a radical improvement of the Wabash River before the main river to which it is tributary has been adequately provided with navigation facilities.

4. In my opinion, this river is not worthy of further improvement by the United States at the present time, and I am unable, therefore, to concur in the recommendation of the district officer that $25,000 be allotted for a survey.

H. C. NEWCOMER,
Lieut. Col., Corps of Engineers,
Division Engineer.

[1] Not printed.

[Third indorsement.]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
Washington, March 6, 1911.

1. Respectfully returned to the Chief of Engineers, United States Army.

2. This is a report on preliminary examination of Wabash River from its mouth to Terre Haute. After an extended discussion of physical and commercial conditions and various plans of improvement the district officer expresses the belief that this stream is worthy of careful and serious consideration in order to determine whether or not its permanent improvement is practicable within reasonable cost.

3. He states that present information in regard to the river is not sufficient for the preparation of suitable plans for its improvement by any method and he recommends that a detailed survey be authorized at an estimated cost of $25,000 for the purpose of securing the physical data necessary for the preparation of such plans and an estimate of the cost. The division engineer is of opinion that the river is not worthy of further improvement by the United States at the present time and does not concur in the recommendation for the survey.

4. The Wabash is one of the principal tributaries of the Ohio, the improvement of which has been undertaken with a view to completion in 12 years. The Wabash valley is very fertile and is rich in natural resources, and at a number of towns along its banks there are large manufactories. At present there is very little water-borne commerce, as the condition of the river will not permit useful navigation. If the river could be improved so as to provide continuous navigation, it would have great potential value as a transportation route. The feasibility and desirability of its improvement can not be satisfactorily determined without a full knowledge of its physical condition and the probable cost of the improvement.

5. In the opinion of the board this further information should be secured, and therefore the board concurs with the district officer in recommending the authorization of a survey.

For the board:

WM. T. ROSSELL,
Colonel, Corps of Engineers,
Senior Member of the Board.

[Fourth indorsement.]

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, March 13, 1911.

1. Respectfully submitted to the Secretary of War.

2. This is a report on preliminary examination of Wabash River from its mouth to Terre Haute, Ind., authorized by the river and harbor act of June 25, 1910.

3. Inviting attention to the report of the Board of Engineers for Rivers and Harbors in the preceding indorsement, I recommend that a survey of the locality, as proposed, be authorized.

W. H. BIXBY,
Chief of Engineers, U. S. Army.

[Fifth indorsement.]

WAR DEPARTMENT, *March 14, 1911.*

Approved.

ROBERT SHAW OLIVER,
Acting Secretary of War.

APPENDIXES.

LETTER REQUESTING INFORMATION.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky.. August 19, 1910.

GENTLEMEN: The last river and harbor act provided for an examination of Wabash River from its mouth to Terre Haute, Ind., with a view to the advisability of its improvement, and the duty of making this examination has been assigned to me.

2. In so far as the physical characteristics of the river are concerned they are well known to this office; therefore the examination will be of the nature of an investigation to determine what the improvement will mean to the various communities involved as to its commercial value. In other words, if there are any commercial possibilities, probabilities, or actualities which the improvement will serve, it will be very desirable to have them fully set forth in any report that is made on the subject; and it is desired to submit this report on or before October 1, 1910. I request that you give this matter such attention as you may consider it deserves, and that as soon as practicable you communicate to me such information as you may have or may obtain. I would welcome any information on the following points, or which would lead me to the proper sources from which to obtain it.

3. (*a*) Your freight rates to Louisville, Cincinnati, Pittsburgh, St. Louis, Evansville, Memphis, Kansas City, and New Orleans on the heavy grades of freight shipped from your locality.

(*b*) In what quantity is freight shipped from your town or vicinity and where is its principal market?

(*c*) From what locality or localities do your heavy shipments of freight come, in what quantities, and what are your rates?

(*d*) In what state of improvement are your county roads?

(*e*) Have you a public wharf on the Wabash River or access to one?

(*f*) How much freight, if any, is carried by boat, annually, to and from your locality, and of what does it consist?

(*g*) Give the names and tonnage of the boats which have called at your town or its vicinity in the year ending January 1, 1910.

(*h*) Are there any of the natural resources of your vicinity which would be developed by the river improvement—an estimate of the quantities that could be put out? Where would these products find a market?

(*i*) If there are any river men in your organization or accessible to you, I would like their opinion as to the benefits that would be derived by them from a thorough snagging of the Wabash River from its mouth to Terre Haute.

4. Should your organization not care or be able to enter into this general subject I would be obliged to you to communicate the contents of this circular to any responsible citizen whom you consider as interested.

5. You will observe from the above that definite information is desired rather than general opinions, and in order that the matter be presented in a fair light all the points specifically mentioned above should be covered by answers, though the answers may not be a strong argument for the river.

Very respectfully,

LYTLE BROWN,
Captain, Corps of Engineers.

LETTER OF THE COMMERCIAL CLUB OF TERRE HAUTE.

THE COMMERCIAL CLUB OF TERRE HAUTE,
Terre Haute, Ind., October 11, 1910.

DEAR SIR: Replying to your letter of inquiry of August 19, 1910, regarding the proposed improvement of the Wabash River.

Freight rates fourth and fifth classes from Terre Haute, Ind., to points named below by rail are as follows:

To—	Fourth class.	Fifth class.
Louisville, Ky	15.5	12.5
Cincinnati, Ohio	14.5	11.5
Pittsburgh, Pa	21.0	18.0
St. Louis, Mo	14.5	11.5
Evansville, Ind	12.5	9.5
Memphis, Tenn	39.0	34.0
New Orleans, La	54.0	44.0
Kansas City, Mo	38.0	32.0

Rates to Louisville, Cincinnati, Pittsburgh, St. Louis, and Evansville are governed by official classification. Rates to Memphis and New Orleans are governed by southern classification, while rates to Kansas City are governed by western classification.

Everything shipped out of Terre Haute may be classified as heavy freight, comprising as it does such articles as merchant iron, malleable castings, steel castings, gray iron castings, brass castings, automobile parts, building brick, paving brick, beer, boilers, bottles of all kinds, canned goods of all kinds, cement blocks, coal-mining machinery, concrete-building-block machinery, dies, dynamos, electrical machinery, engines, enameled ware, feed, fencing, flour, galvanized-iron products, gasoline engines, handles for tools, hominy, ice, mineral waters, oils, paper, meat-packing-house products, sewer pipe, drain tile, stokers, scales, structural iron, building tile, wheels of all kinds, whisky, coal, etc.

The quantity of heavy freight shipped out of Terre Haute for the year 1909, exclusive of coal, pas approximately 1,210,000 tons. The coal shipments from Terre Haute under normal conditions will run from 1,200 to 1,500 carloads per day. These figures do not include through cars interchanged with railroad connections. The inbound tonnage handled by the various railroads of Terre Haute for the year 1909 was approximately 2,785,000 tons. The heavy freight shipped from this city goes in all directions, and is pretty equally divided in the distribution to the four points of the compass.

The inbound heavy shipments come from the north, east, and south. The rolling mills ship iron in considerable quantities from the south. At the present time very rich iron-ore deposits are being developed in southeastern Missouri in the neighborhood of Cairo, Ill., which could be brought to the coal fields of Indiana for manufacturing purposes if adequate means for transportation at reasonable rates were provided. Large quantities of grain of various kinds are also shipped in here from the south. Freight rates on these articles are proportionate with the rates quoted above.

The county roads of Vigo are in fairly good condition, more attention being given to improvement of this kind each succeeding year.

Our city has no public wharf, but there is one on the river to which access has always been given. An effort is now being made to purchase this, and it will be successful.

At the present time there is no freight carried by boat to or from this city. The river is not in boating condition, consequently there is no boating. This should not be considered an argument against the improvement of the Wabash River, however, from our standpoint. From Terre Haute to the mouth of the Wabash River it flows through five counties in Indiana and eight counties in Illinois. The Indiana counties follow and produce annually the following crops, in bushels:

Counties.	Corn.	Oats.	Rye.	Wheat.
Vigo	1,750,000	307,000	37,700	447,000
Sullivan	2,178,000	362,000	1,230	388,000
Knox	3,452,000	156,000	2,200	886,000
Gibson	2,326,000	92,000	1,500	1,185,000
Posey	2,214,000	42,000	430	1,272,000
	11,920,000	959,000	43,060	4,178,000

The Illinois counties follow and produce annually the crops set forth, in bushels:

Counties.	Corn.	Oats.	Rye.	Wheat.
Clark	2,293,000	653,000	7,800	247,000
Crawford	1,785,000	334,000	640	450,000
Lawrence	1,747,000	183,000	400	469,000
Wabash	1,041,000	132,000	140	380,000
Edwards	817,000	171,000	200	189,000
White	2,621,000	132,000	1,100	1,002,000
Gallatin	1,521,000	38,000	400	570,000
	11,825,000	1,643,000	10,680	3,307,000

In Indiana, running north and south, there is practically but one railroad which connects the Wabash River counties with Terre Haute, and the same statement applies with equal force to the Wabash River counties in the neighboring State of Illinois. Next to Peoria, Ill., Terre Haute is probably the largest distilling point in the United States. It also has a hominy mill which consumes 16,000 bushels of corn every 24 hours throughout the year. It has a grain elevator with a capacity of 1,000,000 bushels, and in addition to these it has a number of other corn-consuming plants. It is the natural market for nearly all the corn raised in the Wabash River counties of the States of Indiana and Illinois, and with a navigable river not only the corn but the other grain and farm products raised in the counties named would find a ready market in Terre Haute.

The value annually of the products of the Wabash River counties south of Terre Haute are as follows:

	Farm products.	Manufactured products.	Total.
Gibson County, Ind	.....	.....	$4,265,715
Knox County, Ind	.....	.....	5,229,064
Sullivan County, Ind	.....	.....	2,367,100
Vigo County, Ind	$1,642,242	$28,385.050	30,027,292
Clark County, Ill	1,968,096	503,637	2,471,733
Crawford County, Ill	1,513,507	301,820	1,815,327
Gallatin County, Ill	1,037,895	457,468	1,495,363
Hardin County, Ill	334,541	84,314	418,855
Lawrence County, Ill	1,388,016	317,929	1,705,945
Pope County, Ill	710,846	198,535	909,381
Wabash County, Ill	842,867	352,592	1,195,459
White County, Ill	1,963,150	490,756	2,453,906
Total	11,401,160	31,092,101	54,355,140

The value of steam railroads in the five Indiana counties on the Wabash River south of Terre Haute is in the neighborhood of $8,000,000, and electric railroads in the neighborhood of $450 000. assets vary. Statistics are not at hand for Illinois counties, so they can not be given in this connection.

The manufacturing establishments of the cities on the Wabash River from Terre Haute south, together with the number, capital, and value of products, are given as follows:

Cities.	Number.	Capital.	Value of products.
Mount Vernon, Ind	86	$713,217	$1,382,349
Princeton, Ind	87	605,351	929,270
Terre Haute, Ind	429	8,938,107	27,784,619
Vincennes, Ind	109	1,552,386	2,282,384
Carmi, Ill	35	115,166	169,171
Mount Carmel, Ill	52	249,527	285,066
Total	798	12,173,754	32,832,859

By counties the manufacturing establishments of the Wabash River from Terre Haute south are given as follows:

	Number.	Capital.	Value of products.
Gibson County, Ind	199	$1,078,468	$2,118,983
Knox County, Ind	189	1,844,281	2,787,822
Posey County, Ind	164	934,958	1,791,586
Sullivan County, Ind	128	329,688	595,692
Vigo County Ind	473	9,262,259	28,385,050
Clark County, Ill	125	281,385	503,637
Crawford County Ill	83	157,366	301,820
Gallatin County, Ill	54	314,684	457,468
Hardin County, Ill	21	38,987	84,314
Lawrence County, Ill	68	153,482	317,929
Pope County, Ill	53	94,291	198,535
Wabash County, Ill	67	290,537	352,592
White County, Ill	97	327,008	490,756
Total	1,721	15,107,394	38,386,184

The natural resources of this neighborhood which would be developed by the river improvement are our shale and clay products and our coal. The shale and clay deposits of this neighborhood are practically inexhaustible and are capable of producing the best of everything in that line; paving brick made here are at the present time being used on the Isthmus of Panama. These brick are now shipped from Terre Haute to New York and from New York to Panama by water. With a navigable river they could be sent direct to New Orleans and from there to the Isthmus. These, together with building brick, sewer brick, draintile, and hollow building blocks, would find a ready market, provided the river were navigable at all points between this and the mouth of the Mississippi River. Some of the finest clay plants in the United States are located in Terre Haute. Probably the greatest asset which the State of Indiana possesses is its coal. The counties bordering on the river from Terre Haute south have a coal area of 1,800 square miles, with a total estimated tonnage of workable coal of 6,804,600,000 tons, which is being mined at the rate of 2,285,000 tons, valued at $1,517,250, annually. Much of this coal would find a market in the south along the river if there were any means of reaching those towns.

The Wabash Valley is one of the largest revenue-producing districts in the United States, its annual receipts amounting to nearly $19,000,000, of which 90 per cent is paid by the two towns of Terre Haute and Vincennes.

At all points in the United States where the railroads come in competition with navigable waterways freight rates are lower in proportion than they are at points where there is no waterway competition. This being the case, a navigable Wabash River would tend to keep freight rates on a lower basis, and would likewise produce better service. The country needs all the means of transportation which can be made available. The railroads in most cases have more freight than they are able to handle, and it is impossible to secure quick service on through shipments. With river transportation through freight would go to its destination without changes from one road to another and without sidetracking.

A navigable Wabash River would open up to this region a southern trade which it does not now possess. It would also afford it easy access to the lumber district of the south, from which nearly all our supply at present comes.

The figures which are given in these statistics are rather old, being taken from Census Report of 1900 and succeeding years, and would make a much better showing were the later statistics available.

Respectfully submitted.

THE COMMERCIAL CLUB OF TERRE HAUTE,
By W. H. DUNCAN, *Secretary.*

Capt. LYTLE BROWN,
Corps of Engineers.

LETTER OF THE COMMERCIAL CLUB OF TERRE HAUTE.

THE COMMERCIAL CLUB OF TERRE HAUTE,
Terre Haute, Ind., November 28, 1910.

DEAR SIR: According to promise made during your recent visit to Terre Haute you will find inclosed herewith letters from 33 of the most important manufac-

turers and business concerns of Terre Haute in regard to the improvement of the Wabash River from this point south.

In procuring these letters no request was made for a favorable communication. The matter of approval or disapproval was left entirely with the writer. You will observe, with probably one exception, the letters are all favorable, and if we had an extension of time could secure as many more.

The letters represent the most prominent business and manufacturing concerns of our city to-day, and are a fair expression of the opinion and sentiment which prevails here. You will notice that the drift of opinion is to the effect that if navigation on the Wabash was once established it would open up a trade in the South with this community which it does not now possess, and which, under existing circumstances, it never can possess. It would also open up a trade with this city in all the counties along the river south of here with which at the present time it has little or no communication.

As you wish to have these letters in before December 1, 1910, I am sending them to you at this time. If you wish anything further along the same line, this organization will be very glad to obtain it for you.

Very truly, yours,

W. H. DUNCAN, *Secretary.*

Capt. LYTLE BROWN,
Corps of Engineers.

LETTER OF THE LOUDON PACKING CO.

THE LOUDON PACKING CO.,
Terre Haute, Ind., November 17, 1910.

MY DEAR SIR: Replying to your favor of November 17, would say our tonnage amounts to between 250 and 300 cars per year, not more than five or six of which go to southern points, such as Memphis, New Orleans, and Texas. Our plant was formerly located in Cincinnati, and when there we did considerable business in the South, as we were able to secure very favorable rates of freight by Ohio River steamers. Since moving the plant to Terre Haute, we have practically abandoned southern business, as we can get an outlet for all our goods in Chicago, St. Louis, and points beyond where rates of freight are considerably less than the present carload rates of freight from here to points south. As all of our goods are sold at delivered prices, we are obliged to figure closely on freight rates. We can ship to St. Paul, Minneapolis, and Duluth from Terre Haute at a lower rate of freight by lake and rail than we can now get from here to Memphis or New Orleans We believe that the competition of river rates would result in materially lower rates from Terre Haute to southern territory, in which case we could largely increase our business in that direction, and we would be very glad to see some system of river improvement carried out which would result in a practical waterway between Terre Haute and southern territories.

Yours, truly,

THE LOUDON PACKING CO.,
CHAS. F. LOUDON, *President.*

Mr. W. H. DUNCAN, *City.*

LETTER OF THE SPARKS MILLING CO.

SPARKS MILLING CO.,
Terre Haute, Ind., November 17, 1910.

DEAR SIR: Replying to your favor of the 17th in reference to our business in connection with the proposed improvement of the Wabash River, we would state as follows:

Our company is engaged in the manufacture of flour; merchant millers, with mills at Alton, Ill., and Terre Haute, Ind.

The capacity of our Terre Haute mill is 750 barrels per day, and we figure that 160,000 barrels per annum would be a normal business.

This production amounts to 800 carloads of 20 tons each.

In connection with this there is a production of 300 carloads of feed of 20 tons each.

The wheat required to produce the above is approximately 750,000 bushels, or 750 cars of 30 tons each.

The coal required is approximately 5,000 tons, or 100 cars of 50 tons each.

In connection with our flour mill here we have wheat storage capacity of 170,000 bushels.

The production of wheat in Vigo County, of which Terre Haute is the center, is approximately 375,000 bushels per annum. In other words, working at normal per annum, we would require double the amount of wheat raised in this county.

Obviously we must draw wheat from a considerable distance, and we do draw wheat from a radius of 100 miles.

If the Wabash River were navigable, with a reasonable stage of water, we should be able to draw considerable wheat from the territory between Terre Haute and Hutsonville, which, by the way, is a very good wheat territory, large quantities being produced along both banks of the stream.

A large part of our product goes south of the Ohio River into the various southern States and, with favorable facilities, much of it might be transported by water.

We have nearly 300 feet of river frontage between Ohio Street and Wabash Avenue, which is available for wharfage and which is available for use at no expense and with no restrictions other than the protection of our interests.

The writer has been actively concerned for 20 years in moving freight in large quantities, and is convinced that from both a physical and a financial standpoint it will be almost impossible for ample transportation to be provided over the next few decades as rapidly as such is required.

On this account we should bend every energy to provide additional means of transportation, both water and rail, and we may be well sure that such will be required faster than such can be provided.

Yours, truly,

W. L. SPARKS, *Vice President.*

Mr. W. H. DUNCAN,
Secretary Commercial Club, City.

LETTER OF THE PETTYJOHN CO.

THE PETTYJOHN CO.,
Terre Haute, Ind., November 18, 1910.

GENTLEMEN: We received yours of the 17th instant, and in reply will say that our shipments are of such a nature that river transportation would not be of any direct benefit to us.

We feel confident, however, that the river improvement would be of benefit to those who have shipments of heavy bulk.

Yours, very truly,

THE PETTYJOHN CO.,
L. PETTYJOHN, *President.*

COMMERCIAL CLUB, *City.*

LETTER OF THE ROOT GLASS CO.

ROOT GLASS CO.,
Terre Haute, Ind., November 18, 1910.

DEAR SIR: Replying to your request of the 17th instant, we beg to advise we manufacture bottles that must withstand high pressure, namely, beer and carbonated water bottles, a considerable amount of which are shipped to the southern territory and would be affected considerably and, we believe, favorably if the Wabash River was made navigable. We also believe it would have a reducing effect on the freight rates to competitive territories, and under these conditions Terre Haute would be benefited very greatly. Beg to remain,

Very truly, yours,

ROOT GLASS CO.,
C. J. ROOT, *President.*

Mr. W. H. DUNCAN, *Secretary,*
Terre Haute, Ind.

LETTER OF THE INLAND STEEL CASTING CO.

INLAND STEEL CASTING CO.,
Terre Haute, Ind., November 18, 1913.

DEAR SIR: Your letter of November 17 received referring to the feasibility of Wabash River improvement. So far as our individual business is concerned the river improvement would do us no good. There is nothing that could possibly come to us by river, unless it would be coal from the Pittsburgh district, which would not be practical, we do not believe, as it would have to be hauled from the river to our plant after it arrived in Terre Haute, which would necessitate a great amount of extra cost. At the present time we are shipping nothing to the south.

It may be that the improvement of Wabash River would do a great many firms in Terre Haute good, but the writer believes if the river was dammed and water power furnished the city of Terre Haute that it would do its citizens much more good financially.

We believe if the traction company and the water works had water power sufficient for their requirements that water in Terre Haute would be put on somewhere near a reasonable basis and that power and light could be greatly reduced in price.

Yours, truly,

INLAND STEEL CASTING CO.,
B. J. STEELMAN, *Secretary.*

Mr. W. H. DUNCAN,
Secretary Commercial Club, City.

LETTER OF THE VIGO COOPERAGE CO.

VIGO COOPERAGE CO.,
Terre Haute, Ind., November 18, 1910.

DEAR SIR: Replying to your favor of the 17th instant, beg to say that an improvement of the Wabash River can be a material benefit to us in allowing us to put our products into Vincennes, Evansville, and Cincinnati, and by competing with the different cooperage concerns of Cincinnati and other cities of Ohio and Indiana.

You asked the amount of our business in dollars and cents, also the tonnage in and out. Our business amounts to an average of $600.000 a year; our inbound is about 13,000 tons and our outbound is about 1,500 tons.

We would be pleased to give you all the assistance we can in procuring improvement of the Wabash River.

Yours, truly,

VIGO COOPERAGE CO.,
H. S. BENSON, *General Manager.*

Mr. W. H. DUNCAN,
Terre Haute, Ind.

LETTER OF THE WABASH MANUFACTURING CO.

WABASH MANUFACTURING CO.,
Terre Haute, Ind., November 19, 1910.

DEAR SIR: We have yours of November 17th and in reply wish to say that we are very much interested in the improvement of the Wabash River and feel certain that when improved it would be a decided advantage to Terre Haute in the way of better freight rates to the south.

We manufacture children's wagons and sleds, also a line of porch furniture. The wagons and porch furniture can be sold largely throughout the South and about 25 per cent of our business comes from that section, and no doubt this can be increased a great deal with better shipping facilities in the way of lower rates.

Our tonnage in and out is about 900 to 1,000 tons a year, and quite a portion of this is lumber which comes from the South, and beyond question if this

could be brought up from the Southern States by water route the freight rate would be much less and save reloading at Cairo.

In view of these conditions, we would like very much to see the river improved and hope it may be accomplished.

Yours, truly,

WABASH MANUFACTURING CO.,
W. R. WILSON, *Secretary and Treasurer.*

Mr. W. H. DUNCAN,
Secretary Commercial Club, Terre Haute, Ind.

LETTER OF THE CHAS. W. BAUERMEISTER CO.

CHAS. W. BAUERMEISTER CO.,
Terre Haute, Ind., November 19, 1910.

DEAR SIR: Replying to your recent letter relative to the improvement of the Wabash River, we wish to say that we do not suppose there can be any question in anyone's mind what such an improvement would mean to Terre Haute and all the territory along said river to its mouth.

We are in the wholesale grocery business; and while we do not do an extensive business with the river towns, we know that if these towns were accessible by the river that we would be able to increase our business in that territory 90 per cent. Under present conditions this territory is practically inaccessible to us or any other jobbing point.

We are convinced also that if the Wabash River were improved our freight rates to and from other points would be reduced, for we know it is a fact that we are paying a higher rate of freight on lard shipped out of St. Louis to Terre Haute, which is a distance of about 165 miles, than our jobbing friends situated along the Ohio River ranging from 200 to 250 miles from St. Louis.

We do not see why Terre Haute would not become one of the largest shipping points in the Middle West, situated as it is at the head of one of the finest streams in the country, which under present condition is practically useless.

Yours, truly,

CHAS. W. BAUERMEISTER CO.

Mr. W. H. DUNCAN,
Secretary Terre Haute Commercial Club, City.

LETTER OF THE TERRE HAUTE HANDLE CO.

THE TERRE HAUTE HANDLE CO.,
Terre Haute, Ind., November 19, 1910.

DEAR SIR: In answer to your letter of the 17th will say that this company would be very much pleased to have the Wabash improved, as it would aid us in shipping in and out.

From August, 1909, to August, 1910, this company shipped in as raw material 2,400 tons and shipped out as finished handles 540 tons.

As one-third of our handles are for export, we believe that we could double our trade if we could have them carried by water, thus cutting down the freight rate so as to compete with factories in the East.

Anything we may be able to do to help you in any way if it is in our power we will always be pleased to do.

Yours, very truly,

THE TERRE HAUTE HANDLE CO.,
J. E. WALDRON,
Secretary and Treasurer.

Mr. W. H. DUNCAN,
Secretary Commercial Club of Terre Haute, Terre Haute, Ind.

LETTER OF THE STANDARD WHEEL CO.

STANDARD WHEEL CO.,
Terre Haute, Ind., November 19, 1910.

DEAR SIR: Having reference to the proposed improvements of the Wabash River, and particularly to the inquiries in your kind favor of the 17th instant, we are pleased to call attention to the following:

This company is engaged in the manufacture of vehicle wheels and wheel material, selling to the jobber and manufacturing trade only.

Our product is distributed to nearly every State in the Union, particularly those west of Buffalo and Pittsburgh.

In normal years our net sales average from $500,000 to $600,000 per annum, the raw material represented in the above amounts being approximately $275,000 to $350,000.

Of this material 80 per cent, or $220,000 to $280,000, is forest products, which come to us in the shape of butts, bolts, or billets, lumber, dimension stock, and rough hub blocks.

During the current year our inbound shipments of forest products alone will be approximately 200 carloads, or about 5,000 tons. This is carload shipments and does not include steel and iron products, coming mostly from the East, approximately 800 to 1,000 tons in addition.

Out of the above tonnage about 125 cars, or 3,000 tons, will come from southern Indiana and Illinois, Kentucky, Tennessee, Arkansas, Louisiana, and southern Missouri, all of which points could be reached by or in connection with Wabash and Ohio River boat traffic.

Hickory and oak timber, which we use exclusively, has been pretty well cut off most of the land accessible to railroads in southern Indiana and Illinois; that is, the large tracts are about exhausted. There is, however, quite an abundance of this timber still standing in the counties of Sullivan, Knox, Gibson, and Posey, Ind., and Crawford, Lawrence, Wabash, and White, Ill., each of which fronts on the Wabash River. We receive occasional shipments now on scows brought up the river, but on account of the uncertainty of the channel, and there being no regular boat traffic, the business amounts to practically nothing.

We are of the opinion that if the river were navigable boat lines could be made profitable for carrying this class of freight, where speed is not an item of necessity, and would create a source of revenue to landowners in adjoining counties for reasons above stated.

Our outbound shipments will approximate 2,500 to 4,000 tons per annum, a large portion of which is less than carload shipments.

Of this quite a proportion, say from 20 per cent to 30 per cent, goes to points on or south of the Ohio River and to Mississippi River points, as well as Arkansas and Texas points.

The nature of our product requires that it be transported with reasonable promptness, and there would not be so great a proportion of the outbound movement that could be handled by river traffic as would be the case with reference to inbound traffic.

As to the effect the improvement of the Wabash would have on freight rates, would say that north and south freight rates in this territory are controlled by what is known as the Ohio River committee of the Central Freight Association.

The rates in which we are interested—that is, on forest products—are the same on all wagon material in the rough or in the white between two given points.

These rates to Terre Haute rate from 6 cents from Evansville to 8 cents from Brookport, Ill. The Evansville rate but a few years ago was 5 cents.

Effective November 1, the rate from other Ohio River crossings from Cincinnati to Cairo, inclusive, was increased 1 cent, but these rates have been suspended pending adjustment of hearings before the Interstate Commerce Commission in connection with other advances which were to have been made effective at the same time.

With the Wabash River navigable as far as Terre Haute we are of the opinion that sufficient traffic could be handled to act as a regulator of rates to a considerable extent, and that rates from Ohio River points to Terre Haute and contiguous territory would be reduced or, without question, they would not be advanced.

If the Wabash River could be improved and made navigable for boats capable of handling any traffic offered and can be improved at anywhere near a reasonable cost it certainly should be done.

Yours, very truly,

STANDARD WHEEL CO.,
W. C. CLARK,
Secretary and Treasurer.

Mr. W. H. DUNCAN,
Secretary Commercial Club of Terre Haute, Terre Haute, Ind.

LETTER OF COLUMBIAN ENAMELING & STAMPING CO.

COLUMBIAN ENAMELING & STAMPING CO.,
Terre Haute, Ind., November 21, 1910.

DEAR SIR: Your letter of the 17th instant regarding Wabash River improvement plans came duly to hand. The writer thinks undoubtedly, if it is found practicable to improve the river so that it may be navigable, the scheme will have great value to the commercial interests of the towns and cities situated on the river taken as a whole. The value of the improvement to us could only be indirect, in so far as it would have an influence or bearing on railroad rates. While we could, of course, use river shipments to a certain extent in transporting our goods to Ohio and Mississippi River jobbing points, it could only apply on a small percentage of our product, as even to these points many of the shipments would necessarily go by rail because of quick deliveries demanded. In our line of manufacture our customers do not order or stock heavily, as they depend upon us shipping promptly when in need of stocks in our line. Possibly with river shipping facilities we could induce them in a great many instances to anticipate and allow us to ship by water.

Yours, very truly,

COLUMBIAN ENAMELING & STAMPING CO.,
By W. TOPPING,
Viee President and General Manager.

Mr. W. H. DUNCAN,
Seeretary Commereial Club of Terre Haute,
Terre Haute, Ind.

LETTER OF THE EHRMANN MANUFACTURING CO.

THE EHRMANN MANUFACTURING CO.,
Terre Haute, Ind., November 21, 1910.

DEAR SIR: In our opinion the improvement of the Wabash River, as at various times set forth in publication, would be an immense value to the city and to ourselves. We used to ship goods up and down the river, but on account of uncertain navigation this has ceased. A good many people used to work for us who lived in towns up and down the river and we shipped goods back and forth to them by boat, but as stated, the river was so unreliable at times on account of low water, etc., we had to discontinue this. Consequently these people can not, therefore, get work.

It certainly would be a good thing all around to have the river so that we could use it.

Yours, truly, THE EHRMANN MANUFACTURING CO.

Mr. W. H. DUNCAN,
The Commercial Club of Terre Haute, City.

LETTER OF THE COOK & BLACK DRUG CO.

COOK & BLACK DRUG CO.,
Terre Haute, Ind., November 22, 1910.

DEAR SIR: With reference to shipments down the Wabash River, will say we are greatly in favor of it. I can remember in the eighties when we sent lots of goods by boat down to Darwin, York, Hutsonville, Merom, and other points below.

I think we could probably increase our business $50,000 a year.

Yours, very truly,

COOK, BLACK & HOFFMAN.

Mr. W. H. DUNCAN,
Seeretary Commereial Club, City.

LETTER OF MR. P. S. MACE.

TERRE HAUTE, IND., *November 21, 1910.*

DEAR SIR: I have your letter of inquiry of the 17th instant, relative to improvement of Wabash River.

There is no doubt in my mind but that the improvement would be of inestimable benefit to the city. My business is hardwood lumber manufacturing

of the value of about $35,000 to $45,000 per year, and the tonnage in is about 9,000 tons; that out is about 3,200 tons.

If the river were improved, it stands to reason that freight rates would be reduced, as it would create competition. I am familiar with river territory south, and I know there is a large amount of grain hauled from the river bank to the railroad. All of this grain in addition to that raised farther back would be much more convenient to haul direct to the river.

The Wabash Valley is a great territory for corn, and though other grains are cultivated, corn is the principal crop. I would judge there would be many commodities shipped south by river, such as brick and tile.

If the river route were improved, it would carry more trade to and from Terre Haute from the fact it would be the only direct route to this territory.

Very truly, yours.

P. S. MACE.

Mr. W. H. DUNCAN,
Secretary Commercial Club,
Terre Haute, Ind.

LETTER OF THE A. B. MEWHINNEY CO. (INC.).

A. B. MEWHINNEY CO. (INC.),
Terre Haute, Ind., November 22, 1910.

DEAR SIR: Complying with your request for information regarding tonnage of our freights and value of our shipments both in and out, beg to say that our records show that in the past 12 months we have shipped 6,800 tons of freight inbound and the value of these goods amounted to $189,761.46. We also find that our outbound shipments amount to $268,346.97. A large part of these goods being sugar and other products used in the manufacture of candy was from the territory on or near the great waterways of the Ohio, Mississippi, and Missouri, and the freight rates from these points would be very much less if we had a water differential.

During this period of 12 months we paid for freight $5,062.54 on inbound shipments, but as our product is sold f. o. b. here we can not estimate the amount of freight that was paid by our customers on out outgoing shipments.

We are extremely anxious to see the Wabash made navigable and feel that it will mean to Terre Haute an outlet for her products that will mean many times the cost in the remuneration our factories will receive from this new market.

Yours, truly,

A. B. MEWHINNEY CO.,
OMAR C. MEWHINNEY,
Vice President.

Capt. LYTLE BROWN.
Corps of Engineers.

LETTER OF THE INDIANA BITUMINOUS COAL OPERATORS' ASSOCIATION.

INDIANA BITUMINOUS COAL OPERATORS' ASSOCIATION,
Terre Haute, Ind., November 23, 1910.

DEAR SIR: Referring to your favor of the 22d instant, I did not answer yours of the 17th, for the reason that I regarded it as a circular letter propounding questions concerning business which did not at all apply to my office.

As to the desirability for and necessity of the improvement of the river it appears to me that there is no room for a difference of opinion. Given the opportunity of water shipments, and Terre Haute will find the markets.

The results of such water freights would not only be helpful to the city of Terre Haute, but would benefit all the people adjacent to the river along its entire course.

Like every other new development or invention it would create its own necessity, and the incalculable benefits would be more apparent in years hence than it is now, and the question of the future will not be, Why was the river improved? but, Why was the improvement so long delayed?

Yours, truly,

P. H. PENNA.

Mr. W. H. DUNCAN, *Secretary, City.*

LETTER OF THE TERRE HAUTE VITRIFIED BRICK CO.

TERRE HAUTE VITRIFIED BRICK CO.,
Terre Haute, Ind., November 23, 1910.

DEAR SIR: We are pleased to refer to your letter of the 17th relative to the recent visit of Capt. Lytle Brown, of the United States Engineering Corps, who came to investigate the practicability of improving the Wabash River, so as to make it navigable for barges. The writer has been away from home for several days, hence the delay in answering your letter.

We are manufacturers of vitrified shale paving blocks. Our factory is located just west of the river, and such an improvement would therefore be of very great benefit to us, as it would enable us to reach territory down the river that it is impossible for us to touch now, because of the exorbitant railroad rates.

The tonnage of our production at the present time amounts to about 700,000 tons. If we could reach the Wabash and Ohio River cities, it would enable us to very greatly increase our capacity. The value of our production now is nearly $200,000 per annum, and about one-third of this goes south.

There are immense beds of shale all along the Wabash River, and the manufacture of products from this material is in its infancy. Should this improvement go through, factories will spring up all along the river, and those already in operation will be very greatly enlarged.

We have a machine capacity now of about double what we are making, and all that it would be necessary for us to do would be to add to our battery of twenty-six 30-foot down-draft kilns to enable us to double our capacity, and this would be done at once if this river trade was made accessible. We are, therefore, greatly in favor of this improvement and hope that Capt. Brown will see his way clear to make such a recommendation.

Yours, very truly,

TERRE HAUTE VITRIFIED BRICK CO.,
By J. M. HOSKINS, *Vice President.*

Mr. W. H. DUNCAN,
Secretary the Commercial Club of Terre Haute, City.

LETTER OF THE AMERICAN CLAY CO.

AMERICAN CLAY CO.,
Terre Haute, Ind., November 22, 1910.

DEAR SIR: Replying to your favor of the 17th, our 30-chamber producer gas-fired kiln (which is the largest "continuous kiln" in the country, and which we had the pleasure of showing to Capt. Lytle Brown when he visited this city), produces about 75,000 tons of fireproofing annually, which sells for about $400,000 delivered.

As we ship considerable of this tonnage to St. Paul, Minn., Texas points, and to New Orleans and other southern points, and the freight charges amount to about one-third of the total value, anything which will prevent the threatened advance in railroad rates or which would reduce the present rates would have the effect not only of benefiting the consumer, but would also widen our market.

About one-fourth of this tonnage is to points which could be reached by the Ohio and Mississippi Rivers, so we would doubtless be able to ship some of our product by the Wabash River if it was made navigable, but the greatest benefit to the shippers of this section would likely be the effect this improvement would have in regulating the competitive railroad rates, which would not only benefit Terre Haute, but the points to which our rates were lowered also.

Under these circumstances we certainly are heartily in favor of the proposed improvement in the Wabash River and will be glad to do what we can to aid in the matter.

Yours, truly,

AMERICAN CLAY CO.,
By FRANK R. HALE,
General Manager.

Mr. W. H. DUNCAN,
Secretary, Commercial Club, Terre Haute, Ind.

LETTER OF E. H. BINDLEY & CO.

E. H. BINDLEY & Co.,
Terre Haute, Ind., November 23, 1910.

DEAR SIR: It is with the keenest interest we write you in regard to the improvement of the Wabash River from Terre Haute to its mouth.

It is very hard to foretell the great benefit this improvement would be to us, as it would open up an entirely new territory for us as jobbers and would place us on an equal footing with the Cincinnati and Chicago jobbers, as we could bring all our heavy goods by water instead of rail.

Our volume of business runs from $300,000 to $350,000 each year, and while the tonnage is not large everything we sell is brought to us by rail and leaves by rail, and most every article runs in the first-class freight rate.

Hoping you meet with success in this great improvement, we are

Very truly, yours,

E. H. BINDLEY & Co.,
J. B. BINDLEY.

Mr. W. H. DUNCAN,
Secretary Commercial Club.

LETTER OF WABASH BRICK CO.

WABASH BRICK Co.,
Terre Haute, Ind., November 23, 1910.

DEAR SIR: We have your two favors of recent date requesting an expression of opinion from us as to the value of our business would be the improvement of the Wabash River, from here to its mouth. As you probably know, the bulk of our business is locally, but as the efficiency of our plant increases more attention would be paid to shipments. This spring, had the Wabash River been in a navigable state, we could have landed easily an order amounting to $2,000.

Besides that, the improvement of the river would make it possible for us to secure business from a field that is at present unprofitable. Most assuredly do we indorse this movement and trust that the interest you so much desire will be taken in this by the manufacturers and business men of this city. Should this advice not be explicit enough in regard to the facts and figures, then we would be glad to go into things about our business in detail.

With best wishes, we are,

Yours, very truly,

WABASH BRICK Co.

Mr. W. H. DUNCAN, *City.*

LETTER OF STAHL-URBAN & CO.

STAHL-URBAN & Co.,
Terre Haute, Ind., November 23, 1910.

DEAR SIRS: Replying to yours in regard to the improvement of the Wabash River, would say, while we ship very few articles south, we think the improvement of the Wabash River would be a good thing in so far as it would have a tendency to reduce freight rates, and in that way benefitting us; and, furthermore, we would have a great many piece goods brought up by river which now come by railway.

It might possibly open up some accounts for us in the South, allowing us to compete with southern manufacturers, which is now impossible on account of the high freight rates.

Hoping you will be successful in your endeavors to improve the Wabash, and having our hearty indorsement, we are,

Yours, very truly,

STAHL-URBAN & Co.

COMMERCIAL CLUB,
Terre Haute, Ind.

LETTER OF UP-TO-DATE MANUFACTURING CO.

UP-TO-DATE MANUFACTURING Co.,
Terre Haute, Ind., November 23, 1910.

DEAR SIR: Replying to your favor of the 17th, will say that our in-and-out tonnage per year is approximately 1,000 tons—that is, 500 tons in and same

amount out. The inbound freight we receive comes from Pittsburgh and which would be affected considerably by the river rate, and could all of it be shipped in by water transportation if we had the river in shape to carry it.

We have quite a southern trade and could treble it if it was not for excessive freight rates to a good many points, which we think river rate would affect. I would judge that at the present time we ship about 100 tons of our product to southern points. We manufacture all kinds of wire and iron fence and structural iron work.

We would think the improvement of Wabash River would effect quite a saving in freight rates—just what per cent we are not in position to know, but it would undoubtedly be one of the best things that could happen the city, and we are heartily in favor of improvement and would be willing to spend time and money to get it.

Yours, truly,

UP-TO-DATE MANUFACTURING CO.,
J. H. SROFE, *President and Manager.*

Mr. W. H. DUNCAN, *City.*

LETTER OF NATIONAL DRAIN TILE CO.

NATIONAL DRAIN TILE CO.,
Terre Haute, Ind., November 23, 1910.

DEAR SIR: We have your letter of the 22d, in regard to the proposed improvement of the Wabash River, and in reply will say it seems to us that the opening up of this natural waterway would have marked effect upon freight rates, both to and from Terre Haute. At least such has been the history of navigable waterways, and since our city would be put in direct touch with the very heart of the Southern States, there is but one conclusion to reach, and that is that such an improvement would materially reduce freight rates, which, in turn, would give every manufacturer a direct benefit, and which would also be indirectly of benefit to every citizen here.

We are therefore heartily in favor of the project and trust that nothing will be left undone that can be done for the furthering of this project.

Yours, truly,

NATIONAL DRAIN TILE CO.,
Per L. R. W.

Mr. W. H. DUNCAN,
Secretary Commercial Club,
Terre Haute, Ind.

LETTER OF VIGO CLAY CO.

VIGO CLAY CO.,
Terre Haute, Ind., November 21, 1910.

DEAR SIR: Your favor of the 17th at hand and contents noted. We are manufacturers of hollow building blocks, partition tile, flue lining, drain tile, and book tile, and our shipments last year amounted to over 100 tons a day. We feel that in certain directions, especially south, we are handicapped by excessive railroad freight, and that in case of river improvement our business would be materially benefited and our outgoing freight largely increased.

Yours, truly,

THE VIGO CLAY CO.,
By J. H. CLOY, *Secretary-Treasurer.*

Mr. W. H. DUNCAN, *City.*

LETTER OF INDIANA MILLING CO.

INDIANA MILLING CO.,
Terre Haute, Ind., November 23, 1910.

DEAR SIR: Replying to your recent favor concerning our opinion as to the advantages of improving the Wabash River, we have this to say: Since the establishment of our business in 1904 we have been unable to do any business south of the Ohio River, with the exception of selling one car, which went to an Alabama town. Our business is the manufacture of a stock feed, and our

inbound and outbound tonnage for the past year was about 50,000 tons. We feel quite sure that should the Wabash River be made navigable we would be enabled to procure a rate which would enable us to do business in the South—for instance, Memphis, New Orleans, and other towns along the river. We are now laboring under a disadvantage of from $1 to $1.40 per ton on account of the arbitrary railroad rates to southern points. We believe we could increase our tonnage 10,000 to 20,000 tons per year if the Wabash should be opened. On the whole, we think it would be a splendid thing for Terre Haute from a business standpoint, both for inbound and outbound shipments generally.

Yours, truly,

INDIANA MILLING CO.

Mr. W. H. DUNCAN,
Secretary Commercial Club, City.

LETTER OF FOUTS & HUNTER CARRIAGE MANUFACTURING CO.

FOUTS & HUNTER CARRIAGE MANUFACTURING CO.,
Terre Haute, Ind., November 25, 1910.

DEAR SIR: We are not in favor of improving the Wabash River. Under the circumstances we are unable to indorse the effort. We remain,

Yours, respectfully,

FOUTS & HUNTER CARRIAGE MANUFACTURING CO.,
Per WM. A. HUNTER.

Mr. W. H. DUNCAN,
Secretary Commercial Club, City.

LETTER OF TURNER BROS. CO.

TURNER BROS. CO.,
Terre Haute, Ind., November 25, 1910.

DEAR MR. DUNCAN: We have your two letters of the 17th and 22d, and have given the matter considerable thought, with the idea of writing you such a letter as would be of benefit in advocating the feasibility of improving the Wabash River. We have not been able to figure out in our own minds how and in what manner the river transportation would be of any practical benefit to us while our shipments are almost exclusively in carload lots, both in and out shipments; but even though it might not benefit us particularly, if such improvement would in any manner benefit others we would certainly not wish to do anything that would interfere with the work.

Our business amounts to about $700,000 per annum, and the shipments are about 2,000 carloads per annum, which include in and out shipments. Out of this amount we have about 200 cars of lumber coming from the South and which might be shipped advantageously by river, and our out shipments south to Cincinnati, Louisville, Cairo, Memphis, New Orleans, and other points south amount approximately to 500 cars per annum.

If a regular and well-equipped line of boats should be run on the river thus improved, there can be but little doubt but a good business could be built up, and there can be but little doubt that such competition would have the effect to lower the present rates for transportation to the South. Whether such improvement would benefit us to any great degree or not, we would, of course, be pleased to have the great Indiana stream made a transportation route for all points to the South.

Yours, sincerely,

TURNER BROS. CO.,
By L. L. T., *Secretary and Treasurer.*

Mr. W. H. DUNCAN,
Secretary Commercial Club,
Terre Haute, Ind.

LETTER OF KESTER ELECTRIC CO.

KESTER ELECTRIC CO.,
Terre Haute, Ind., November 25, 1910.

DEAR SIR: Replying to your letter of the 17th; also your letter of the 22d, vill say that the Kester Electric Co.'s manager is much in favor of the im-

provement of the Wabash, and that while personally he does not believe it would benefit the Kester Electric Co. greatly, he does believe that it would make lower freight rates on wheat, corn, oats, and possibly some coal, and that after the river was navigable that the freight tonnage would increase probably more than even the most enthusiastic person would now claim.

Very truly,

KESTER ELECTRIC CO.,
Per CHAS. VAN SLYKE, *Manager.*

Mr. W. H. DUNCAN,
Secretary Commercial Club of Terre Haute,
Terre Haute, Ind.

LETTER OF THE COMMERCIAL DISTILLING CO.

THE COMMERCIAL DISTILLING CO.,
Terre Haute, Ind., November 25, 1910.

DEAR SIR: Replying to your letter of the 17th, in reference to proposed improvements of the Wabash River, would say that we are greatly in favor of making the Wabash River navigable to Terre Haute.

In addition to the advantage to other lines of business than ours in the city of Terre Haute, which advantages we believe would be many fold, it would enable us to handle the immense corn crop in the Wabash Valley to an advantage which does not now exist.

Our shipments to southern points are heavy and we believe that with the opening of navigation on the Wabash that the shipments, or a large part of them, would go by boat.

We are heartily in favor of the improvement and will join in doing anything that will help it along.

Very truly, yours,

JOHN E. BEGGS, *General Manager.*

Mr. W. H. DUNCAN,
Secretary Commercial Club, Terre Haute,
Terre Haute, Ind.

LETTER OF THE TERRE HAUTE PAPER CO.

THE TERRE HAUTE PAPER CO.,
Terre Haute, Ind., November 25, 1910.

DEAR SIR: Replying to your recent communication relative to the question of proposed improvement of the Wabash River, will state that we do not have an extensive trade in the South at this time but have some customers, and doubtless if the proposed improvement is carried out it would stimulate trade with the South and give us an opportunity to do business in that section to a much greater extent.

We receive annually approximately 20,000 tons of straw to be used in the manufacture of strawboard. There is a goodly quantity of straw located along the Wabash River, which could be secured if there were means of transportation. We can not doubt for a moment but what the project would be certain and produce great benefits to all the manufactures in this city, and we sincerely trust that the plans will materialize, and that the Wabash River will be made navigable.

While we have a very limited knowledge of the effects of water navigation, we understand that cities located on the Mississippi River enjoy much lower rates than inland cities. Same condition applies, of course, to points on the Ohio River.

We can not at this time give you the data as to the volume of our in and out bound shipments, as we have not the figures compiled which would furnish the information. We are most assuredly in hearty accord with the movement.

Yours, truly,

THE TERRE HAUTE PAPER CO.,
H. WASHBURN, *Secretary.*

Mr. W. H. DUNCAN,
Secretary Commercial Club, Terre Haute, Ind.

LETTER OF TERRE HAUTE BREWING CO.

TERRE HAUTE BREWING CO.,
Terre Haute, Ind., November 26, 1910.

DEAR SIR: We are in receipt of your favor of the 22d instant, regarding the proposed improvement of the Wabash River and wish to state that we are heartily in favor of this project, as we are satisfied it would open up a new territory to the Terre Haute merchants and manufacturers.

Wishing you success, we remain,
Yours, very truly,

TERRE HAUTE BREWING CO.,
By W. HIMMELBAUER.

Mr. W. H. DUNCAN,
Secretary, Terre Haute, Ind.

LETTER OF TERRE HAUTE MALLEABLE & MANUFACTURING CO.

TERRE HAUTE MALLEABLE & MANUFACTURING CO.,
Terre Haute, Ind., November 26, 1910.

DEAR SIR: In regard to proposed improvement of the Wabash River, which we find is up for consideration at the present time, will state that we are confident that such improvement as contemplated will benefit not only the factories and shippers of Terre Haute, but all shippers and manufacturers between here and New Orleans, and, in fact, for hundreds of miles east on the Ohio River.

We can readily understand that there would be considerable opposition to making this river navigable, as the railroads would find their business reduced to a certain extent, but as we are believers in competition we are confident that it would benefit the communities referred to to such an extent that it would mean the greatest satisfaction to all.

In the past the connection between Terre Haute and the South along the Ohio and Mississippi was of such narrow margin that it was practically absurd to even expect any southern trade whatever. The opening of the Wabash will most assuredly stimulate trade from that section and would put us in position where river rates would give us an advantage over eastern and western cities.

We are in hopes that Capt. Brown was convinced to the effect that he would recommend the Government to take charge of the matter without great delay.

We sincerely hope that a decision will be rendered in favor of improving the Wabash.

Yours, truly,

TERRE HAUTE MALLEABLE & MANUFACTURING CO.,
H. J. WANNER, *Secretary and Treasurer.*

P. S. Our output is approximately 6,000 tons malleable castings annually. We employ 300 men and operate the entire year.

T. H. M. &. M. Co.

Mr. W. H. DUNCAN,
Secretary, Commercial Club, City.

LETTER OF HULMAN & CO.

HULMAN & CO.,
Terre Haute, Ind., November 26, 1910.

DEAR SIR: In regard to the improvement of the Wabash River from Terre Haute to its mouth, will say that we heartily indorse the project.

There is a large area of country south of Terre Haute in the States of Indiana and Illinois, bordering on the banks of the Wabash, which is absolutely without transportation of any kind. In this area there are a number of good towns on both sides of the river, which are miles away from the railroads. This region is also one of the best corn-growing countries in the United States, as well as the heart of the largest coal field. Therefore, this part of the country would be benefited the same as Pittsburgh by having water transportation. The freight rates on the railroads are too exorbitant, and they are increasing the

freight rates instead of reducing them; for whenever they increase their facilities for transportation and increase the size of their locomotives and cars they virtually have to build a new railroad every time, and the people in the country have to pay for the same.

As the product of this country, like coal, gravel, and clay products, need low rates of freight, which we can only get by having the Wabash improved, this project should be promoted, as we are far behind foreign countries in the operation of facilities of cheap water routes which compete with the railroads and reduce the freight rates. Therefore it is time that we should wake up and improve all the waterways—all the important rivers of this country, and particularly the Wabash River, which needs improvement about as much as any river in the United States. Therefore I heartily indorse the project and hope to see the Wabash River improved in the near future.

Very truly, yours,

H. HULMAN.

Mr. W. H. DUNCAN,
Secretary the Commercial Club of Terre Haute, City.

LETTER OF WALLIS STOKER & MANUFACTURING CO.

WALLIS STOKER & MANUFACTURING CO.,
Terre Haute, Ind., November 29, 1910.

DEAR SIR: Responding to the request of Capt. Lytle Brown, would say: While the business of the Wallis Stoker Co. is not large at present, it is capable of indefinite extension. Its greatest market is in the South, because in that section no automatic stoking devices are manufactured. The business of the company would be benefited by the improvement of the Wabash by reduction and regulation of freight rates. There is, in our opinion, no legislation, however efficient, which will so effectually regulate rates as waterway improvement.

From our business relations with manufacturers in the Wabash Valley and elsewhere we are confident they will all be substantially benefited by the improvement of the Wabash River.

Sincerely hoping the project may be undertaken, we are,

Yours, very truly,

WALLIS STOKER & MANUFACTURING CO.,
By GEORGE M. CRANE, *Secretary and Treasurer.*

Mr. W. H. DUNCAN,
Secretary Commercial Club.

EXTRACT OF LETTER FROM MAYOR OF VINCENNES, IND.

EXECUTIVE DEPARTMENT, CITY OF VINCENNES,
Vincennes, Ind., November 7, 1910.

DEAR SIR: In reply to your communication of August 19, I beg to submit the following report on local conditions with reference to the Wabash River.

I recently issued a call for a public meeting of all persons interested in the Wabash River improvement, and the various questions propounded by you were submitted and discussed as fully as possible, but I regret to state that a very small amount of information was obtained which, in my opinion, would be of any material value to you, for the reason that river traffic at this point has been a dead issue for so long. * * *

I have the honor to submit herewith a table of freight rates to important cities, compiled by Mr. B. R. Harsha, secretary of the board of trade, and a man of long experience in railroad circles.

The commodities that would constitute the major portion of river traffic would be corn, wheat, lumber, merchandise, mussel shells, coal, and stone.

Our natural resources are timber, stone, coal, and gravel for use in the improvement of public highways.

Practically all of the following boats are local craft, and while not large as regards tonnage are used chiefly for transportation of timber, corn, and

mussel shells: *Lone Star*, *Joe Wheeler*, *Grey Hound*, *Roy H.*, *Echo*, *Roamer*, *Mary H.*, *Newark*, and *May Flower*. All are gasoline boats, with engines ranging from possibly 8 to 20 horsepower.

We have a public wharf owned by the city, and extending four squares, from Broadway to Church Streets. Knox County has in the last few years expended about $500,000 on improved roads, and any point of interest can now be reached by either a gravel or crushed stone road.

The proposition of snagging the river from its mouth to Terre Haute met with hearty approval from all river men present, and the reason advanced was the fact that if snags were removed, not only would the safety of our present limited navigation be enhanced, but in addition the channel would deepen to a degree as a result of the river being afforded the opportunity to "scour its bed."

* * * * * * *

In conclusion, permit me to offer what appealed to me as being the most logical and important reasons for the proposed improvement advanced at our meeting. In the Wabash Valley, "corn is king," has been for years, will continue for years to come. The nearer the river, the better the product, as a result of the annual deposits from the high-water overflows.

The treachery of the Wabash River in recent years, as regards overflowing, is so marked that the farmers can take no risk with the crops, but must haul the same, as a rule, many miles as soon as harvested and store in a high and dry place for security. If a navigable river was available, this monster crop would be loaded on boats at the time of gathering and brought direct to the market, thus obviating the necessity of hauling the same to high ground for storage or hauling many miles to railway stations, and then paying cost of transportation to market.

I regret very much that it is impossible to obtain the data for a more complete report, but river traffic at this point has retrograded so markedly that it is extremely difficult to obtain. Our people are extremely anxious for the improvement, but feel so discouraged over the long line of previous failures that hope seems to be practically abandoned.

With kindest regards I am,

Very truly, yours,

J. D. McDowell, *Mayor.*

Capt. Lytle Brown,
Corps of Engineers.

STATEMENT OF THE VINCENNES BOARD OF TRADE.

Vincennes Board of Trade (Inc.),
Vincennes, Ind., November 5, 1910.

	Wheat.	Corn.	Bridge material.	Straw-boards.	Alcohol, high wines, etc.
Louisville	0.08	0.08	0.125	0.080	0.150
Cincinnati	.08	.08	.115	.080	.145
East St. Louis	.06	.06	.105	.070	.090
Pittsburgh	.16	.16	.190	.135	.225
Evansville	.06	.05	.075	.045	.110
Memphis	.11	.10	.130	.150	.250
New Orleans	.18	.16	.220	.250	.400
Kansas City	.19	.18	.325	.180	.370

The above rates are in cents per hundred pounds and in carloads, excepting alcohol, high wines, etc., to New Orleans and Memphis, which is in any quantity.

Vincennes Board of Trade,
B. R. Harsha, *Secretary.*

SURVEY OF WABASH RIVER, IND. AND ILL.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., March 10, 1914.

From: The District Engineer Officer.
To: The Chief of Engineers, United States Army
(Through the Division Engineer).
Subject: Report of survey, Wabash River from its mouth to Terre Haute, Ind.

1. There is submitted herewith a report of a survey of the Wabash River from its mouth to Terre Haute, with special report as to improving said river up to Mount Carmel by dredging. (Act of June 25, 1910.)

2. The very thorough preliminary examination of this stream was made by my predecessor as district officer, Maj. Lytle Brown, Corps of Engineers. He gave particular attention to the natural resources of the valley and to the present and probable future commerce. For a consideration of these subjects attention is respectfully invited to his report.

3. On his recommendation a survey was authorized. Parties were organized, sent into the field, and a thorough survey of the river from Terre Haute to the mouth was made under the direction of Assistant Engineer George H. Wolbrecht. For results of this survey attention is invited to his report (Appendix A) attached hereto, which gives the methods and features of the survey, peculiarities of the river, results of work previously performed by the United States to improve the river, costs of survey, etc.

4. The results of the survey have been mapped on 64 charts, half-size reproductions of which, with profile sheets, are forwarded with this report.[1] These charts show the river bed and banks and about a thousand feet of land on each side of the river. In addition to the charts submitted the survey has been mapped on 13 charts.[1] This latter map shows the whole flood plane of the river valley, with 5-foot contour intervals. The reproduction of these charts has not been completed and no copies are as yet available.

5. Much information about this river has been printed in official documents and may be found as follows:

Reports on preliminary surveys may be found on page 458, Annual Report of the Chief of Engineers, fiscal year 1871, and page 472, Annual Report of the Chief of Engineers, fiscal year 1872.

Preliminary examination, Logansport to Delphi, page 1649, Annual Report of the Chief of Engineers, fiscal year 1885.

Preliminary examination, Terre Haute to Lafayette, page 2411, Annual Report of the Chief of Engineers, fiscal year 1891; also House Document No. 65, Fifty-first Congress, second session.

Preliminary examination, above Vincennes to Perrysville, page 2726, Annual Report of the Chief of Engineers, fiscal year 1904; also House Document No. 196, Fifty-eighth Congress, second session.

Survey, from Vincennes to mouth of river. page 2729, Annual Report of the Chief of Engineers, fiscal year 1904; also House Document No. 568, Fifty-eighth Congress, second session.

Preliminary examination, Mount Carmel to mouth of river, House Document No. 246, Sixty-first Congress, second session.

None of the foregoing reports contains maps.

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[1] Index map only printed.

6. For a number of years appropriations were made by the United States, and work for improving this stream was carried on. At the time the work was begun the river was badly obstructed by bars, accumulations of snags, rocky reefs, and numerous secondary channels or cut-offs. Navigation was impracticable except at high stages of water. A lock and dam had been built at Grand Rapids by the Wabash Navigation Co., and a few improvements had been made at other places also by private enterprise; but as none of them was of a substantial character, they rapidly deteriorated and became useless.

7. The original project and outline of improvements proposed is found in the report of Maj. C. Weitzel, Corps of Engineers, January 4, 1872, page 472, Annual Report of the Chief of Engineers for 1872. The first appropriation was made by Congress June 10, 1872. This project proposed the improvement of the river from its mouth to Lafayette, Ind., by special works at 12 designated localities, the construction of a new lock and dam at Grand Rapids, and the general work of snagging and dredging. Work at various places other than those mentioned in the project was added from time to time, but no general revision of the original estimate was made.

8. The river and harbor act of March 3, 1881, made separate appropriations for work above Vincennes and for work below Vincennes, thus dividing the original project, and subsequent to that date funds were provided separately for each section. Work was carried on as follows:

(*a*) *Below Vincennes.*—Subsequent to 1881 work was continued under the original project, but the estimates were modified from time to time as necessity therefor arose, as in the cases of the dam for closing the New Harmony cut-off, the lock and dam at Grand Rapids, etc. Levee work at Grayville, Ill., was added in 1887, and completed, as proposed, at a cost of $25,000. In 1898 a plan and estimate, amounting to $50,000, for additional work at New Harmony was approved, but at the same time it was urged that if the improvement of the river was to be continued the old project should be abrogated, a comprehensive survey of the river made, and a new project formulated, based upon data furnished by the survey, and of sufficient scope to meet existing needs of commerce. The survey was authorized and funds therefor provided by the river and harbor act of June 13, 1902. The report of the survey, proposed plan for improvement, estimate of cost, and action taken in connection therewith may be found on page 2729, Annual Report of the Chief of Engineers for 1904.

The expenditures to March 31, 1881, amounted to $317,845.44, in addition to the $7,000 paid to extinguish the franchise of the Wabash Navigation Co. and acquire their property; $25,000 for the levee work at Grayville, from 1887 to 1892; and $365,111.76 for other work since 1881 on this part of the river, or an aggregate of $714,957.20 for work below Vincennes.

Previous to 1885 a fairly good channel for boats having a draft not exceeding $2\frac{1}{2}$ to 3 feet was maintained, but as the river and harbor act of July 5, 1884, made specific appropriation for a lock and dam at Grand Rapids, near Mount Carmel, Ill., the suspension of operations elsewhere became necessary, in view of the fact that the funds available since that date were not sufficient to complete the

lock and dam and at the same time maintain the former works for bank protection and to concentrate the water flow and clear the channel of obstructions. Consequently the work formerly done deteriorated rapidly, the structures being destroyed by ice and high water or rendered useless by the water cutting its way around them. The channels, cut through rock reefs and shoal places, became choked with snags, stumps, and bowlders, thus leaving the river without any permanent improvement excepting that resulting from the lock and dam at Grand Rapids. Through navigation at low water became impracticable. Boats drawing 20 inches could pass from Mount Carmel to Vincennes (a river distance of about 34 miles) at all stages, but could reach Mount Carmel, 94.7 miles from the mouth of the river, only when the gauge at the lock read 7.5 feet or more, on account of the obstruction due to the cut-off at New Harmony.

(*b*) *Above Vincennes.*—There was no change in the original project for work above Vincennes, and a small amount of money was expended for a number of years on this stretch of the river without materially improving conditions. The expenditures amounted to a total of $95,254.87.

Appropriations for the improvement of the Wabash ceased in 1902. Since that date the lock and dam at Grand Rapids have been operated and maintained by annual allotments from the indefinite appropriation for "Operating and care of canals and other works of navigation," act of July 5, 1884, as amended by act of March 3, 1909.

The total expenditure by the Government on improvements and operating and care of lock to June 30, 1913, is as follows:

Below Vincennes	$714,957.20	
Above Vincennes	95,254.87	
		$810,212.07
Operating and care of lock		82,332.95
Total for river		892,545.02

As a result of this expenditure nothing remains to-day except the lock and dam at Grand Rapids and a number of cuts through rock bars, which produced no beneficial result. For description of several localities where work was carried on and the results see Appendix A.

9. It is not considered necessary for me to repeat the descriptions of the physical characteristics of the stream and all the data described in Mr. Wolbrecht's report, but it is necessary to invite attention to some of the prominent facts that have an important bearing on the problem of improving this stream.

10. The distance from Terre Haute to the mouth is 214.4 miles. The fall over that distance at mean low water is 132 feet, giving an average slope per mile of 0.615. The slope, however, is far from uniform, being very slight in the pools and steep over the bars. The greatest slope occurs at the New Harmony cut-off, where, in a distance of less than 2,000 feet, there is a fall of 5.3 feet, part of this fall being over the sill of an old dam which was built to close the cut-off and which was afterwards destroyed.

11. The valley of the Wabash is postglacial; that is, the stream flows in a valley cut through material that was deposited during the melting of the glaciers at the termination of the glacial era, the material being composed to a very great extent of silt, sand, and fine gravel. Bedrock shows at intervals, but the larger portion of the river bed and banks are sand and sand and fine gravel.

12. The bed of the stream may be divided into sections as follows: Sand, 103 miles; sand and fine gravel mixed, 88 miles; gravel, about 18 miles; bedrock for about 5.4 miles.

13. The banks of this stream are low, at very few places rising more than 16 feet above mean low water, and nearly all of the concave banks are caving. Altogether there are 68 miles of caving banks. The mean low-water discharge at Terre Haute is estimated at 1,890 cubic feet per second, and at the mouth at 2,500 cubic feet per second. The bank-full stage at each of these places, respectively, is estimated at 43,700 and 85,000.

14. The stream overflows its banks two or three times each year, and it is difficult to obtain its maximum discharge. As a result of all available data, it is estimated that the maximum discharge at Mount Carmel, 94.7 miles from the mouth, is 385,000 cubic feet per second. At such times the stream is about 7 miles wide and the flood level is 11.4 feet above the general bank level in the vicinity of Mount Carmel.

15. Ohio River floods back water long distances up the Wabash. The 1913 flood levels coincided with the Wabash low-water level 88 miles from the mouth. At times, when the Ohio River is in flood, the bottom lands of the Wabash for miles upstream are overflowed, the extent of the overflow depending on the height of flood. See Table No. 7, Appendix A.

16. Dam No. 50, Ohio River, will create a pool which will back water up the Wabash, giving a general depth of 6 feet for a distance of 3 miles from the mouth.

17. The greatest obstruction to navigation exists at New Harmony, $41\frac{1}{2}$ miles from the mouth, where the river has shortened its path $7\frac{1}{2}$ miles by breaking through from one bend to another, the length of the cut-off being $2\frac{1}{4}$ miles, and the length around the old river bed about $9\frac{3}{4}$ miles. The cut-off is now the main channel, the old river channel having filled with sediment until there is little or no flow through it at low stages. Under the old project for improving the river a dam was built across the cut-off, but it has since been washed out and only the sill remains.

18. The old river bed is composed of sand, or sand and fine gravel, but the cut-off is over bedrock. The fall from the head to the foot of the cut-off is 6.5 feet. The river at the head of the cut-off having two paths, at medium stages the flow divides and there is not sufficient water in either bed at such stages to provide for navigation, particularly as most of the water goes through the cut-off with great velocity and little depth.

19. According to the tables submitted by Assistant Engineer Wolbrecht, a 6-foot navigable depth exists in the river, at Terre Haute 133 days, Mount Carmel 168 days, and at the mouth 318 days each year; but at New Harmony, on account of the cut-off before mentioned, a 6-foot navigable stage exists only about 75 days annually. It will be seen, therefore, that the stretch of river surveyed is unnavigable for 6 feet during more than nine months in the year, due to this cut-off. With this obstruction overcome or removed, 6 feet could be carried to Mount Carmel between five and six months annually, and could be carried to Terre Haute for about four and a half months annually.

20. The above statements do not take into consideration other difficulties of navigation, such as sharp bends, snags, and bars where the velocities are considerable. The bends are not too sharp for careful navigation, many rivers being successfully navigated having sharper bends than are shown on the maps submitted. As for snags, they could be removed by the ordinary floating derrick or snag boat, and boats with ample power could pass over all bars when the depth is sufficient.

21. No intimation was given in the authorization for the preliminary examination as to what navigable depth was to be considered. The projects for the improvement of the other Ohio River tributaries provide as follows:

Locks and dams on Ohio River tributaries.

River.	Number of locks.	Controlling depth on miter sill.
		Feet.
Monongahela	15	5.0
Allegheny	8	5.0
Big Kanawha	10	6.0
Little Kanawha	5	4.0
Muskingum	11	6.0
Big Sandy	5	6.0
Kentucky	14	6.0
Green, Barren, and Rough	8	5.0
Wabash	1	5.0
Tennessee	15	5–6.0
Cumberland	14	6.5

22. The Ohio is being improved to provide 9 feet navigable depth by the construction of 53 locks and dams.

23. Under very peculiar conditions where the kind and amount of tonnage would warrant the construction of a particular type of boat or barge for that particular tonnage, a depth of 4 feet might be used to advantage, but on this river which passes through sparsely settled agricultural communities, navigation to be successful must provide for a type of steamboat used on the Green, Kentucky, Muskingum, etc. Such boats draw from 3 to 5 feet loaded, and should have a depth of at least 6 feet for safe navigation.

24. It would seem that the Wabash, if improved, should have a least navigable depth of 6 feet. Due to low banks, a greater depth than 6 feet is considered impracticable without the expenditure of sums of money out of all proportion to the benefits to be derived. In studying this problem, therefore, it has been assumed that 6 feet is the proper depth to be provided if we expect the river to be used.

METHODS OF IMPROVEMENT.

25. Rivers may be improved by reservoirs, snagging, dredging, regulation, canalization, lateral canals, or by combinations of these methods.

26. *Reservoirs.*—The navigability of a stream may be improved by increasing the low-water flow and decreasing the extreme flood heights by storing water in reservoirs during months of excessive rainfall, and then during months of drought or low water by supplementing

the natural discharge of the stream by allowing the stored water to gradually escape from the reservoirs.

27. To reduce the flood height at Mount Carmel 1 foot for 10 days would require storage basins of total capacity of 26,000,000,000 cubic feet, which is equivalent to a single basin 100 square miles area, with a mean depth of 10 feet. Omitting such factors as evaporation, seepage, etc., such quantity of water, if returned to the river during the low-water season, would raise the mean low-water stage at Mount Carmel about 3 feet for a period of about 100 days.

28. Referring to the Wabash Basin, theUnited States Geological Survey, in its Water Supply Paper No. 283, 1910, states:

> The high value of farm land in this section would undoubtedly prohibit the construction of reservoirs for storage.

One reservoir, however, exists at the headwaters of this stream and is described in the above-named publication as follows:

> At the headwaters of the Wabash River in Mercer County, Ohio, is a large reservoir, called Grand Reservoir, that is used to store water which is supplied to the Miami and Erie Canal. This reservoir receives the drainage from about 200 square miles, and its capacity is about 4,000,000,000 cubic feet. The water that is thus fed to the canal is diverted from the Wabash River.

29. The extent of the present survey did not include any probable reservoir sites, and from my knowledge of the territory through which the Wabash flows, I feel safe in stating that few, if any, available sites exist, except possibly at the extreme headwaters of the Wabash and the tributaries.

30. What increase in the low-water discharge might be provided by reservoirs at the headwaters it is impossible to state owing to lack of a complete survey of the watershed of this stream. However, it is safe to state that reservoirs alone can not be relied on to make this stream navigable. It may be, at some later date when the territory in question has been completely surveyed, that reservoirs may be provided to assist in the solution of this problem, as well as to protect particular communities from excessive floods.

31. *Snagging.*—Whatever method of improvement may be selected, it will be necessary to remove a large number of snags. The assistant engineer reports that the river is badly obstructed from Terre Haute to Vincennes and is comparatively free below that point. He estimates the total number at approximately 2,000. From my experience with rivers of this type I believe that this estimate is too low, and that when a snagboat begins operations the removal of one snag in sight will uncover several others that are covered at present. It is believed that to keep this river clear of snags will require the continuous operation of a snagboat; at first for clearing the worst of the snags now in sight and later on for removing other snags as they are brought into the navigable section of the stream; to remove overhanging trees that may become snags; to complete the work by a careful examination of the river bed and clearing the same of all snags that may be uncovered during successive rises; and to operate as a clam-shell dredge to keep the approaches to the locks free from deposits. It is necessary to operate such snag boat on improved rivers, such as the Kentucky and Green.

32. It is estimated that a boat suitable for this service can be constructed for $40,000, and that the annual cost of operating, maintenance, etc., will be $15,000.

33. *Dredging.*—This method is not ordinarily considered a principal method of improving rivers. In nearly all cases of improvement by other methods, dredging is either necessary or may be used as an auxiliary method to assist in the improvement.

34. Dredging has been used with some success in large streams like the Mississippi, where the dredged channel forms but a small part of the river bed, and where the depth required is not much greater than is found under natural conditions or in large sluggish streams with small slope like the Volga in Russia; but I know of no successful use of dredging alone for a radical increase in a stream like the Wabash. The rock bars, except the New Harmony cut-off bar, could be blasted and dredged so as to provide a navigable channel with 6 feet depth. However, it would be necessary to deposit the dredged rock to form contracting works in the shape of dikes to force all of the low water flow through the channel thus dredged, else the pool above would be lowered, the depth at first obtained would decrease with the lowering of the pool, and additional bars would be uncovered where at present there is sufficient depth.

35. Cuts through gravel bars might be held for a time, but would become gradually ineffective unless the gravel should be very coarse.

36. On the sand bars it would be absolutely impossible to provide a proper depth and width of channel by dredging alone. These bars are formed by the river in its natural condition by the movement of material along the bottom, or the dropping of material from the waters due to a slackening of the current. To dredge through one of these bars would concentrate the flow from the pool above into the narrower and deeper channel with increase of velocity of flow, thereby creating erosion. The pool above would be lowered, creating new obstructions, and due to erosion the dredged channel would be deepened and broadened until some other bar in the pool became the controlling element and relieved the dredged bar from further erosion. At the next high water the conditions that originally caused the formation of the dredged bars would tend to re-create them, particularly as the material dredged from one bar would have to be deposited in the river bed where it would be washed down on the next lower bar.

37. It will be seen, therefore, that both to maintain the pool above at the previous level, to protect the dredged cut against too great erosion, and to force the water through this cut on a falling river, so that the bar may not be re-created, it would be necessary to hold the channel by auxiliary works, such as contracting dikes and ground sills. Furthermore, at New Harmony it is certain that one of the channels would have to be dammed.

38. It is therefore apparent that dredging alone will not suffice and that dredged channels would have to be held by regulating works, caving banks protected, and the movement of sand and silt downstream stopped as far as possible.

39. *Regulation.*—Regulation is the name given to the method of improvement by which the channel is made more regular; that is, the banks are protected, the width of the channel is made more uniform, the slope is increased where insufficient and decreased where too great, and the depths on the bars are increased and held by contraction works and ground sills. The methods used are bank protection by mattresses or by pavement, contracting the river channel by spurs

or longitudinal dikes on one or both sides of the stream, holding the bottom at places where erosion is great by ground sills, closing cut-offs, and holding the channel away from the concave banks by sloping dikes. This system, if carried to the limit, would produce a stream having the banks and bed of the low-water channel protected throughout, with slope and cross section carefully determined and fixed. In other words, the water would flow in a large gutter.

40. M. Jacquet, engineer in chief, reporting on the improvement of the Rhone, May 13, 1878, states:

> Experience, therefore, shows that to successfully carry out the improvement of the Rhone, it is not enough to improve, one after another, all those passages which at any given time are called troublesome, but that it is absolutely necessary to rectify and permanently fix the entire course of the river.

41. Numerous attempts have been made to improve the navigable depths of rivers by this method, and there are many prominent engineers who believe it possible to obtain marked improvement in depth, as well as better navigable conditions by the means mentioned above.

42. As Maj. Brown in the report of preliminary examination suggests that the Wabash River may be improved by regulation, I feel constrained to give this subject particular consideration and to enumerate certain facts which lead me to disagree with his conclusions.

43. In the first place, even the advocates of this method of improvement admit that it is not applicable to rivers like the Wabash:

> Only rivers, or long reaches of rivers, in which natural erosion is fully developed are adapted to regulation. The navigability of unfinished rivers, still in state of erosion, can be improved with permanent results only by canalization.[1]

The Wabash is clearly an unfinished river, being one of the northern tributaries of the Ohio, whose valleys were filled with glacial deposit and which in point of erosion are classed as very young rivers.

44. But even with rivers whose regimen has become more fixed, little increase in navigable depths even from large expenditures has been obtained by this method, which has been extensively used in Europe and is in use to-day in this country on the upper Mississippi and on one section of the Tennessee. In Germany vast sums of money have been spent in regulating the Rhine, Oder, Elbe, Weser, and numerous smaller streams. In France the Rhone is the only important stream thus treated, although a section of the Loire has been regulated to some extent. The money spent has undoubtedly improved the conditions attending the navigation of the streams, inasmuch as they have been able to decrease the curvature, to fix the shape of the channel, to hold shifting bars, and in particular instances to increase to some extent the depth on the bars.

45. I have, however, sought in vain for any record of radical improvement of depth in any of the rivers of the world improved by regulation alone, except possibly in the Rhine, where the enormous low-water flow, fixed regimen, good general depth, and fairly secure banks place the stream in a class by itself.

46. The Loire has a mean low-water flow of from 1,200 to 1,300 cubic feet per second. From Briare to Nantes, 246 miles, the gradient in feet per mile varies from 2.1 to 1. This stream has a

[1] Prof. Engels, in Trans. Am. S. C. E., Vol. XXIX, p. 220.

depth of from 10 inches at Briare to 2.3 feet at its confluence with the Main, and from 2.6 feet to 3.3 feet at Nantes. Attempts to improve this stream were made as far back as 1835, but were abandoned. In 1894 experiments were begun on a stretch of about 15 miles. M. Kaufman, ingenieur en chef des ports and chaussées, describes the work done as successful,[1] and illustrates by charts 2 miles of improvement. The channel has been confined by spur dikes at close intervals, averaging 15 dikes on each side of the channel per mile, with connecting longitudinal dikes at intervals. The chart shows a good general improvement with minimum depth of 31 inches, but the conditions have not yet become fixed, and the probability is that when the next bars above and below are improved changes will result at this experimental work. The work cost $32,000 per mile.

47. The Rhone was improved before 1860, but not much improvement resulted except at isolated bars or chutes. In 1860 a project depth of 5 feet was adopted for the lower Rhone. This stream has a much larger low-water flow than the Wabash, varying from 8,500 cubic feet per second below the mouth of the Saone to 15,800 cubic feet per second below the confluence with the Durance. From Lyon to Arles, 178 miles (lower Rhone), the slope is approximately $2\frac{1}{2}$ feet per mile, and the present minimum depth is 4.1 feet, allowing a draft of 3.3 feet. The cost of the work on this section, including the maritime Rhone, 208 miles, in the period 1846–1900, averaged $63,000 per mile. It must be admitted that the results seem incommensurate with the expenditure.

48. In Germany many streams have been regulated, the work having been carried on nearly 100 years on the Rhine, Elbe, and Oder, 80 years on the Vistula, and 70 on the Weser. Of these, the stream that most nearly approaches the peculiarities of the Wabash is perhaps the Weser. The Weser has a mean low-water flow of 722 cubic feet per second at Munden and 3,334 cubic feet per second at the mouth of the Aller, considerably greater than the mean low-water discharge of the Wabash at its mouth. The project depth at Munden is 2.6 feet, increasing to 4.1 feet at the mouth of the Aller. They actually have at the present time, after these many years of regulation, 2.1 feet at Munden, increasing to 3.3 at the mouth of the Aller. It will be seen, therefore, that after all of these years they have been unable to obtain a navigable depth at mean low water greater than 3.3 feet at the mouth of the Aller, with a low-water flow greater than that of the Wabash at its mouth, and by the expenditure of nearly $11,000 per mile.

49. In describing this work Mr. Leo Synepher, Dr. Ing. Geheimer Oberbaurat, Berlin, states:

> On the great majority of the stretches the depth hitherto aimed at on the basis of the regulation plans has been attained; here and there, however, places of less depth, which unfavorably affect the working capabilities of the river, are, unfortunately, still found or are in process of formation.[2]

As a result of unsatisfactory conditions the project has now been changed, and it is proposed to reregulate the Weser, and in connection with other works and for other purposes to use storage reservoirs at an estimated cost of over $6,000,000. The new depth to be obtained from the reregulation and the use of storage reservoirs is 2.6 feet

[1] Document No. 6, Twelfth International Congress of Navigation.
[2] Document No. 2, Twelfth International Congress of Navigation.

at Munden, varying to 5.1 feet, or, possibly as an alternate project, 5.7 feet at the mouth of the Aller. The cost of reregulating the stream is estimated at $2,506,190, which with the estimated cost for reservoirs makes an estimated total of over $8,500,000 to spend on this stream in the near future.

MISSISSIPPI.

50. The upper Mississippi River has been as successfully improved by regulation as any stream in Europe. It is under improvement from St. Paul to the mouth of the Missouri, 658 miles, using mainly the measures enumerated above, but with a lateral canal and lock at Keokuk, Iowa.[1] The low-water discharge at St. Paul is about 2,000 cubic feet per second. The slope is very moderate, averaging less than 0.5 foot per mile. The regimen of the stream is perhaps more nearly established than that of any river of similar size in the United States and much more so than that of the Wabash.

51. The project was adopted in 1878 and provides for 4½ feet at extreme low water, this depth to be increased to 6 feet later. Col. Townsend, Corps of Engineers, chairman of the Mississippi River Commission, in writing of this improvement November 4, 1908, states:

> Due to the limited appropriations by Congress and the irregularity with which they have been made the systematic method of improvement adopted on many foreign rivers could not be applied to the upper Mississippi. It has been necessary to distribute the funds available over the entire district, first improving those bars having the least depth of water on them, and when these have disappeared, regulating the next shoalest bars. This process has been continued until at the present time bars restricting the channel to depths less than 3½ feet are seldom found.

The cost of this work to June 30, 1906, was $10,252,653.66, or $15,600 per mile.

52. It should be noted in connection with the above that there are five great reservoirs at the headwaters of the Mississippi with capacity of 93,000,000,000 cubic feet, the largest artificial storage system in the world.

53. The work on the Tennessee River has not progressed far enough to state definitely what success will result, but from a study of the results obtained by similar methods elsewhere it would not be difficult to predict the continuation of the work over a long period of years without much success.

54. An examination of other improved streams similar to the Wabash, or approximating in peculiarities to that river, has given similar results; that is, there has been an improvement in navigable conditions, but the depth of water at low stages has not been materially increased.

55. The cause of this lack of success is, of course, the fact that because of the great cost the improvement has not been carried to the limit which requires practically the whole length of bed and banks of the stream to be paved and regulated. Where a single bar or short stretch is improved without question of cost success may be obtained, as in the experimental section of the Loire, but in my opinion a river may not be improved radically by this method by any reasonable expenditure.

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[1] A power dam with lock has recently been completed at Keokuk, which puts the old lateral canal and lock out of commission.

56. The following table gives data in condensed form relating to the rivers mentioned above:

Name of river.	Period when work was begun.	Number miles under improvement.	Cost per mile approximately.
Rhine	1816	214	$59,752.00
Weser	1842	210	10,718.50
Elbe	1815	252	39,430.50
Oder	1816	337	17,702.50
Vistula and Nogat	1831	176	136,285.00
Loire (experimental section)	1894	15	32,000.00
Rhone	1846	208	63,000.00
Mississippi	1873	658	15,600.00

57. Without including the cost of the Vistula, the average cost of the improvement of the other seven rivers is approximately $34,000 per mile. Considering the peculiarities of the Wabash River, with its shifting bed, caving banks, great variations in discharge, etc., I believe it is fair to assume that amount as the minimum ultimate cost per mile of regulating the Wabash, or a total cost for the 214.4 miles between Terre Haute and the mouth, of $7,293,000. In fact, a rough estimate of the cost of necessary bank protection, spur dikes, ground sills, etc., for complete regulation like that cited for the experimental section of the Loire River amounted to double this amount. I also believe it is safe to assume that the improvement would be no greater than on the streams mentioned above, where the results are incommensurate with the expenditures.

58. It is, therefore, my opinion that to attempt to obtain a material increase in navigable depth in the Wabash River by regulation alone, or even in conjunction with dredging, would entail the expenditure of enormous sums of money. with the great probability that the navigable depth would not be materially increased.

59. *Lateral canal.*—It would, of course, be possible to excavate a lateral canal from Terre Haute to the mouth of the Wabash, but it is not understood that such waterway is to be investigated by this survey. It is understood that the object of the survey is the improvement of the Wabash River, and not the creation of a navigable waterway between Terre Haute and the Ohio River. In order to determine, however, whether such canal would have any material advantage as to cost, the matter has been studied sufficiently to make it evident that, for the kind of navigation now existing on the Ohio and its other tributaries, it will be less expensive to improve the river itself than to excavate a lateral canal.

60. *Canalization.*—By this method the river itself is divided into a series of pools or steps of different elevations, by dams constructed across the stream, but with locks to allow the passage of boats from one pool to the next above or below. Except by the construction of a lateral canal, this method is without doubt the only sure means of improving a stream to provide a definite navigable depth much in excess of the natural low-water depth. A study of the data obtained as a result of the survey shows that the length of the Wabash considered can be improved by this method to provide 6 feet navigable depth at low water throughout the year. However, the banks of the stream are so low that the lifts at the dams must be small, else valuable land will be flooded or the level of the

ground water will be raised so that the land can not be cultivated. In locating the various dams and determining the lifts I have endeavored to keep the surfaces of the pools 5 feet below the surface of the land near the river; but in a few places, particularly with the second system discussed, the pool surfaces are closer to the top of the banks and levees must be constructed to protect areas of low-lying land adjacent to the stream.

61. The lock at Grand Rapids described in Appendix A has the following dimensions: Available length, 214 feet; width, 52 feet. Recently a board appointed by authority of Congress has recommended that in future locks be constructed having dimensions as follows: Small lock, 160 by 36 feet; medium size, 310 by 56 feet; large, 310 by 82 feet.

62. The cost of improving this stream will be so great that the justification for the expenditure must depend upon the development of a very large traffic. For such traffic, the medium-sized lock, 310 by 56 feet, will be none too large, and these dimensions have been assumed in the following estimates. The size 214 by 52 feet is not suitable for the craft now using the Ohio River and its other tributaries. Consequently the Grand Rapids lock should be reconstructed to conform to the dimensions proposed for the other locks.

63. The improvement may be made by the use of permanent dams or of movable dams. Permanent dams have the disadvantage of increasing ordinary flood heights. As the banks of the Wabash River are very low and are overflowed on an average of about three times per year, the greatest problem to the contiguous section of the country is not navigation but flood protection. If permanent dams be used, they must be as low as possible to cause as little damage as possible. This question has been studied carefully and a system of locks and permanent dams has been selected, 19 in number, with lifts from 5 to 8 feet, as about the best that can be devised. The following table gives data relating to the proposed system with costs:

No. of lock.	Location (mile + feet),	Chart No.	Width of river.	Material at site.	Lock on right or left bank.	Lift.	Elevations.		Height of banks.	
							Lower pool.	Upper pool.	Right.	Left.
			Feet.			*Feet.*				
.....	+4,000	64	800	Sand.....	L.....	7.3	320.0	328.0	345	335
.....	10+ 500	61	1,000	.....do.....	R.....	8.0	328.0	336.0	350	345
.....	23+ 900	57	1,150	.....do.....	R.....	6.0	336.0	342.0	355	360
.....	31+	55	1,300	Rock.....	L.....	8.0	342.0	350.0	355	360
[1].....	39+1,150	52	1,150	Rock and sand..	R.....	6.0	350.0	356.0	365	365
.....	57+1,600	47	1,050	Sand.....	L.....	8.0	356.0	364.0	370	370
.....	75+4,360	42	900	Gravel.....	L.....	7.0	364.0	371.0	380	380
.....	88+2,600	38	1,000	Rock and sand..	R.....	8.0	371.0	379.0	390	390
[2].....	97+ 500	35	1,150	Rock.....	L.....	9.3	379.0	388.3	395	395
).....	105+ 600	33	900	Sand and gravel.	R.....	5.7	388.3	394.0	400	400
1.....	118+1,800	29	650	Rock.....	R.....	5.0	394.0	399.0	400	405
2.....	123+1,500	27	600	Sand and gravel.	L.....	6.0	399.0	405.0	410	410
3.....	136+4,900	23	550	.....do.....	L.....	5.0	405.0	410.0	415	415
4.....	147+1,400	20	600	.....do.....	R.....	6.0	410.0	416.0	420	420
5.....	157+3,200	17	450	Rock.....	R.....	8.0	416.0	424.0	430	430
6.....	170+ 650	13	600	Sand and gravel.	R.....	6.0	424.0	430.0	435	435
7.....	182+ 350	10	600	Sand.....	R.....	5.0	430.0	435.0	445	440
8.....	191+ 800	7	550	Gravel.....	L.....	7.0	436.0	442.0	445	445
9.....	199+1,800	5	600	.....do.....	R.....	7.0	442.0	449.0	455	455

[1] This requires dredging 1,000 feet of channel through rock in cut-off.
[2] Grand Rapids lock now in place. Dam to be raised 1 foot. This dam is fixed. Lock to be changed to correspond to rest of system.

No. of lock.	Dredging below dam.		Bank protection in vicinity of lock and dam.	Cost of lock.[1]	Cost of dam.	Cost of lock and dam.	Cost of operation per annum.
	Rock.	Earth.					
	Cu. yds.	*Cu. yds.*	*Sq. ft.*				
1	.....	8,800	[2] 13,500	$235,000	$240,000	$475,000	$2,340
2	.....	24,000	[3] 18,000	235,000	300,000	535,000	2,340
3	.....	41,500	[3] 19,800	200,000	345,000	545,000	2,340
4	17,900	6,500	.....	200,000	260,000	460,000	2,340
5[4]	.....	4,900	[3] 26,100	215,000	315,000	530,000	2,340
6	6,800	11,500	[3] 19,800	235,000	315,000	550,000	2,340
7	.....	4,000	[3] 23,400	230,000	270,000	500,000	2,340
8	4,400	4,400	.....	220,000	260,000	480,000	2,340
9[5]	3,200	.....	.....	150,000	50,000	200,000	2,340
10	9,200	3,800	.....	195,000	270,000	465,000	2,340
11	.....	7,400	.....	180,000	120,000	300,000	2,340
12	.....	.....	.....	200,000	165,000	365,000	2,340
13	.....	9,500	[3] 19,800	190,000	165,000	355,000	2,340
14	5,600	7,000	[3] 18,000	200,000	165,000	365,000	2,340
15	2,900	12,200	.....	250,000	135,000	385,000	2,340
16	.....	11,200	[3] 10,800	200,000	165,000	365,000	2,340
17	.....	2,000	[3] 16,200 [2] 7,200	190,000	165,000	355,000	2,340
18	.....	1,700	[3] 24,300	215,000	165,000	380,000	2,340
19	.....	.....	[3] 22,500	200,000	165,000	365,000	2,340
Total	—50,000	160,400	239,400	.....	.....	7,975,000	44,460
Cost per unit	— $2.00	$0.15	$1.00	.....	.....	.....	.....
Total cost	$100,000	$24,060	$239,400	.....	.....	.....	.....

	Cost of lock and dam.	Cost of operation per annum.
Cost of locks and dams	$7,975,000	$44,460
Dredging rock	100,000	[4] 5,000
Dredging earth	24,060	[5] 15,000
Bank protection	239,400	.....
Snag boat	40,000	.....
Total	8,378,460	64,460

Maintenance not considered; will vary with age of system, damage by floods, etc.

[1] It will be noted that the cost of locks of this system are estimated as costing more than locks of the same lift in the other system. This is because locks with permanent dams require more protection to prevent river washing around them.

[2] Abutment.

[3] Lock site.

[4] Office.

[5] Snag boat.

64. To lower the lifts would necessitate a greater number of locks and dams, which would make the number of required lockages so great that navigation would be unduly hampered with increased costs of transportation. This system can not be recommended, not only because of its great first cost, but because of the damage to agricultural lands that would result, or would be claimed to result, from overflows due, or claimed to be due, to placing of such obstructions in the stream. Very strenuous objections to this system would be made by the owners of property adjacent to the river. Undoubtedly a large amount of land would be injured by more frequent overflows or by raising the ground-water plane high enough to prevent cultivation, and whether in particular cases the dams did contribute to the damage or not, the people interested would believe that the dams were responsible for the damage, and claims would be submitted and damages would undoubtedly be awarded. Besides the land actually damaged and lost from the productive acreage of the

country, for which no estimate is included, great increase of ultimate cost of the improvement would result from interminable suits in the courts.

65. It is, therefore, in my opinion, out of the question to contemplate the improvement of this stream by the use of permanent dams, except perhaps near the mouth, where the banks are higher and the adjacent lands are practically never overflowed unless the Ohio River is in flood. A permanent dam at the mouth would not be as objectionable as elsewhere.

66. There remains to us, therefore, only the method of improvement by movable dams, with possibly a fixed dam near the mouth, and the Grand Rapids dam which is fixed and is to be retained. A movable dam is of some type which allows the raising of needles, wickets, or shutters during low water, so as to provide a pool above, giving a navigable depth over all bars in that pool, and that may be lowered as soon as a flood is imminent to enable the passage of the flood water without undue obstruction. A consideration of the characteristics of the Wabash leads me to the conclusion that the Chanoine wicket dam is undoubtedly the best type for that stream. Consequently the estimates for the costs of improvement have been based upon the construction of movable dams having Chanoine wickets.

67. The width of the river at the proposed lock sites varies from 450 to 1,300 feet. It would be unduly costly and unnecessary for navigation purposes to make the whole length of the dams movable, so each dam is divided into sections, as follows: Navigable pass, movable; regulating weir, movable; permanent weir, fixed. It is believed that navigable passes 300 feet long will be sufficient with their sills at or below the present bottom of the river. The regulating weirs above the White River should be 300 feet long and below that stream 400 feet long. The sills of these weirs at the higher dams should be 4 feet above the pass sills but on the lower dams should be at a less height, depending on height of dam. The remaining width of river at each dam should be occupied by a fixed weir of gravity section, with crest 1 foot below pool level to pass the normal low-water flow. The dam nearest the mouth of the river is to be fixed, of massive gravity section.

68. By using movable dams the pool elevations may be regulated so that flood heights need not be increased. Consequently a system with 14 locks, with 12 movable and 2 permanent dams, has been selected for estimate. The number of dams can not be decreased without sacrificing some important consideration. The use of these dams would require the construction of a few stretches of levees and considerable dredging through bars to provide 6 feet at low water. The cuts through the bars will require some maintenance for a number of years, but it is believed that conditions will be gradually improved so that maintenance costs will be reduced. In deciding on the location of the locks and dams careful study on paper of the available sites has been made, particularly in connection with direction of approaches, shape and stability of banks, height of lift, and length of pool obtainable without destroying agricultural land.

69. The following table gives data with reference to the proposed locks and dams:

Elements and costs of system of locks with movable dams.

No. of lock.	Location (mile+ feet).	Chart No.	Width of river.	Material at site.	Lock on right or left bank	Lift.	Elevations.		Height of bank.	
							Lower pool.	Upper pool.	Right.	Left.
			Feet.			*Feet.*				
1	3+ 350	63	1,150	Gravel and sand.	R	9.3	320.7	330.0	345	345
2	12+1,600	60	1,075	Sand	L	10	330.0	340.0	345	350
3	31+	55	1,300	Rock	L	10	340.0	350.0	355	360
4[1]	39+1,150	52	1,250	Rock and sand	R	10	350.0	360.0	365	365
5	62+1,100	45	1,150	Gravel and sand	R	10	360.0	370.0	375	375
6	88+2,600	38	1,100	Rock and sand	R	9	370.0	379.0	390	385
7[2]	97+ 500	35	1,150	Rock	L	9.3	379.0	388.3	390	390
8	105+ 600	33	950	Sand and gravel.	R	6.7	388.3	395.0	400	400
9	123+1,500	27	650	do	L	10	395.0	405.0	410	410
10	141+1,500	22	600	Gravel	R	10	405.0	415.0	415	420
11	157+3,200	17	500	Rock	R	10	415.0	425.0	480	430
12	175+ 500	12	550	Gravel	L	10	425.0	435.0	440	440
13	191+ 800	7	550	do	L	7	435.0	442.0	450	445
14	199+1,800	5	600	do	R	7	442.0	449.0	455	455

No. of lock.	Dredging below dam.		Levees above dam (fill).	Bank protection (riprap) in vicinity of lock and dam.	Cost of lock.	Cost of dam.	Cost of lock and dam.	Cost of operation per annum.
	Rock.	Earth.						
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Sq. ft.*				
1				[3] 37,500	$245,000	$356,500	$601,500	$2,340
2			2,400		245,000	426,250	671,250	15,000
3	28,000	39,000			200,000	366,000	566,000	15,000
4[1]		4,900	13,000	[3] 26,100	230,000	480,000	710,000	15,000
5			2,600	[3] 26,000	238,000	449,500	687,500	15,000
6		19,000			215,000	400,000	615,000	15,000
7[2]	3,200				150,000	50,000	200,000	2,340
8	9,200		3,000		200,000	372,000	572,000	15,000
9	24,000	4,000			258,000	279,500	537,500	15,000
10		46,000	6,000		250,000	264,000	514,000	15,000
11	3,600	15,000			250,000	230,000	480,000	15,000
12		8,000			260,000	241,000	501,000	15,000
13		1,700		[3] 24,300	215,000	241,000	456,000	15,000
14				[2] 22,500	185,000	241,000	426,000	15,000
Total	68,000	137,600	27,000	136,400			7,537,750	184,680
Cost per unit	$2.00	$0.15	$0.50	$1.00				
Total cost	$136,000	$20,640	$13,500	$136,400				

	Cost of lock and dam.	Cost of operation per annum.
Total cost of lock and dam	$7,537,750	[4] $184,680
Dredging rock	136,000	[5] 5,000
Dredging earth	20,640	[6] 15,000
Levees	13,500	
Bank protection	136,400	
Snag boat and dredge	40,000	
Total	7,884,290	204,680

Maintenance not included; will vary with age of system, damage by floods, etc.

[1] This would provide navigation in old river and cut-off.
[2] Grand Rapids lock now in place. Dam to be raised 1 foot. Lock to be changed to correspond with rest of system.
[3] Lock site.
[4] Locks and dams.
[5] Office.
[6] Snag boat.

70. It will be seen from the above discussion that the river may be improved from Terre Haute to its mouth at an estimated cost of ap-

proximately $8,000,000, either by using locks with permanent dams or with movable dams.

The system with permanent dams will undoubtedly cost less to operate and probably also to maintain. The system with movable dams, however, will cause much less damage to adjacent land. How much such damage would amount to in the course of years is problematical.

In my opinion, therefore, if this river is to be improved, it would be advisable to adopt the system with the movable dams as causing less overflow damage and as offering less obstruction to navigation even when the dams are up and very little obstruction at stages when the dams are down. It is believed that such system can be installed at the present time at current prices for $8,000,000, with annual operating cost of approximately $205,000.

71. *Advisability.*—The question of advisability must be determined by the formation of an opinion as to the benefits to be derived from the expenditure. Maj. Brown in submitting the preliminary report seemed to be much impressed by the natural resources of the country adjacent to the Wabash, and seemed to be of the opinion that if this stream were improved a large amount of traffic might develop between this section of country and the South. After careful study I am forced to the conclusion that such opinion is erroneous. The country adjacent to the Wabash is served by a large number of railroads. There is one on each bank practically paralleling the stream from Terre Haute to the Ohio River. The stream itself is crossed east and west by seven railroads between Terre Haute and the Ohio River and by two railroads at Terre Haute, as follows:

	Miles from the mouth.
Cleveland, Cincinnati, Chicago & St. Louis	215.0
Pennsylvania	214.8
Illinois Central	162.0
Baltimore & Ohio Southwestern	128.2
Cleveland, Cincinnati, Chicago & St. Louis	118.5
Southern	94.5
Cleveland, Cincinnati, Chicago & St. Louis	91.5
Illinois Central	63.3
Louisville & Nashville	30.8

Terre Haute itself is a railroad center, with connections east and west, north and south, to all important commercial points. Except for the lower 30 miles of river, where there is a depth of 6 feet about 10 months of the year, there are few points on the Wabash River that are more than 10 miles from a railroad, and, furthermore, the territory immediately adjacent to the stream is almost wholly agricultural and from the nature of the soil destined to be an important agricultural district for all time. It is true that a large section of the country under consideration is underlain by coal, but it is not at all apparent that this coal must move south. The most thickly populated districts of the United States are north, east, and west of Terre Haute. The only really large cities that might be supplied by water are St. Louis and New Orleans. At the present time the coal necessary for the South is supplied from the Pittsburgh and Alabama districts, and there is no immediate prospect that Indiana coal could compete with the Pittsburgh or Alabama coal. Furthermore, improvements have been made recently in transportation both by water and rail from the Alabama coal districts, and it is almost

certain that New Orleans, Mobile, Pensacola, Galveston, and all points drawing their supplies from these towns will be furnished with coal from Alabama. It seems necessary, therefore, to eliminate from the problem the consideration of coal carrying, at least during the present generation.

72. What other products might be shipped out of this district in future years it is impossible to tell, but with the large southern territory as yet undeveloped it is improbable that there will be a great demand for any manufactured articles from the Terre Haute district that could be shipped more advantageously by water to the South than by rail, in competition with the same industries that are bound to grow up in the as yet undeveloped districts of the South.

73. In my opinion, therefore, the products of this field will be sent north, east, and west, and only a small proportion of such products will be shipped south. It is, therefore, impossible for me to believe that a large traffic awaits the improvement of this stream.

74. Anything less than a positive improvement giving a definite and sufficient depth will result in little or no benefit and will entail the wasting of large sums of money. The positive and sure improvement outlined above will cost too much to be warranted at the present time. It is therefore my opinion that the improvement of the Wabash River at the present time is unworthy of being undertaken by the United States.

75. There are no questions of water power, flood protection, or other related subjects to be considered in connection with the proposed improvement.

SPECIAL REPORT AS TO IMPROVING WABASH RIVER UP TO MOUNT CARMEL, ILL., BY DREDGING.

Mount Carmel is 94.7 miles from the mouth of the river. The condition of this section of the stream is not different from that of the whole section considered in the above report. The greatest obstruction to navigation occurs at the New Harmony cut-off described in paragraph 17. The subject of improving this stream by dredging was treated at length in the discussion of methods for improvement, paragraphs 33–38, inclusive. What was said in those paragraphs applies to the section under consideration, as well as to the whole stretch of the river surveyed.

It is absolutely impossible to provide navigation past New Harmony without the construction of a dam to cut off one of the paths, or else a lock and dam below the junction of the two paths to provide a pool that will extend above the cut-off. Probably the latter method would be preferable, as it would be very difficult to construct a dam across one of the channels that would remain in place owing to the nature of the material of which the banks of the river are formed.

In my opinion, with material such as is found in the Wabash River, dredged channels can not be held without contraction works and paving of the river bed and banks. This leads immediately to the method of improvement by regulation, which is also, in my opinion, impracticable for this stream. I am, therefore, obliged to report that it is not practicable to improve the navigable depth of this stretch of the river materially by dredging alone, nor it is worthy at the present time of improvement by other methods by the Federal Government.

There are no questions of water power, flood protection, or other related subjects to be considered in connection with this report.

The following accompany this report, viz:

Appendix A. Report of Assistant Engineer George H. Wolbrecht.
Appendix B. Instructions for chief of party.
Appendix C. Precise level bench marks—descriptions and elevations.
Appendix D. Traverse line bench marks—descriptions, geographic positions, and elevations.
Appendix E. Auxiliary bench marks—descriptions, geographic positions, and elevations.[1]
Appendix F. Report on precise leveling, by Walter P. Stewart.
Appendix G. Location and result of probing.[1]
Appendix H. Results of discharge measurements.[1]
Maps, sheets 1 to 64, inclusive.[1]
Profile sheets, 1 to 7, inclusive.[1]

The following data [1] on file in the Louisville district office:

River maps: 64 charts, scale 1 inch=400 feet.
Valley maps: 13 charts, scale 1 inch=1,600 feet.
Profile: 7 sheets (tracings), showing thalweg character of bottom, high and low water slopes.
Gauges: Descriptions and gauge-bench marks (letter).
River distances: Tracing.
Computations: Base line, stadia lines, and discharge measurements.
Daily stages: Tracings showing all available gauge readings on Wabash River gauges.
Duration of stages: Curves, showing gauge heights and corresponding number of days.
Disharges: Rating curves.
Notebooks of the survey.

J. C. Oakes,
Major, Corps of Engineers.

[First indorsement.]

Office Division Engineer, Central Division,
March 14, 1914.

To Chief of Engineers:

I agree in general with the views of the district officer and concur with his conclusion that it is not advisable for the United States to undertake any further improvement of the Wabash River at this time.

H. C. Newcomer,
Lieut. Col., Corps of Engineers,
Division Engineer.

[For Report of the Board of Engineers for Rivers and Harbors on Survey, see page 3.]

Appendix A.

October 16, 1913.

From: Geo. H. Wolbrecht, Assistant Engineer.
To: The District Engineer Officer, Louisville, Ky.
Subject: Report of survey of Wabash River.

METHODS AND FEATURES OF THE SURVEY.

In compliance with request of Maj. Lytle Brown, Corps of Engineers, I accepted the position with the Louisville district office to take charge of the survey of the Wabash River and Valley, from Terre Haute to the mouth, and reported for duty on June 5, 1911.

[1] Not printed.

Two small house-boats to be used as quarter boats (*Nos. 1* and *2*) had already been purchased at Vincennes, Ind., and towed to Terre Haute, where they were being remodeled to suit the purposes of the survey party. A large quarter boat (*No. 3*) was under construction at the same place, and three especially designed gasoline launches were being built in the Government shops at the Louisville & Portland Canal, in Louisville.

While waiting for the completion of the plant, methods of operations were planned, parties organized, available data from other surveys secured, requisitions for the necessary survey instruments, and other equipment made.

The proposed survey contemplated a hydrographic and topographic survey of the river proper with borings or probings, and a topographic survey of that part of the valley subject to overflow at a stage just above bank full. In order to secure accurate results, it was decided to run a traverse or base line, measured with steel tape and a triangulation transit, and a line of precise levels with separate bench marks for each, as a basis of the survey.

A set of general instructions for the survey had been prepared by the district officer (Appendix B), and these were followed, except that a few changes of minor importance were made to suit the conditions as the work progressed. Owing to the limited appropriation the special lock-site surveys mentioned in the instructions were omitted.

Plant.—Quarter boats *Nos. 1* and *2* were arranged to accommodate the traverse and precise level parties, *No. 1* being fitted up as a sleeping boat, and *No. 2* contained kitchen, dining room, and office, with four additional bunks in the office for officers. These two parties contained about 26 men and the two boats were much crowded when the party was complete.

The large quarter boat, 100 by 20 feet, was built at Terre Haute to accommodate 28 men, and was amply large for that purpose. All the quarter boats were of light draft, the maximum being 15 inches.

The three gasoline launches were also built to draw not more than 16 inches; they had a heavy hull, contained each a two-cylinder, 12-horsepower Fairbanks-Morse marine engine, and the propellers were placed in a tunnel within the the body of the boats in order to be of service during low-water season, when the channel in frequent places had less than 20 inches of water. The construction of these boats made them rather slow and their speed against the current was about 4 miles per hour, but they were found to be well adapted for towing the quarter boats downstream and carrying parties to and from work, etc.

Owing to the shallow water it was impossible to bring up to Terre Haute one of the Ohio River drill boats; and therefore a small flat, 12 by 24 feet, was built and provided with an A frame, a hand winch, and 25-foot steel rods for probing.

Another small 12 by 24 foot barge was purchased and covered with a cabin to be used as a store boat in connection with quarter boats *No. 1* and *No. 2*.

Six yawls 25 feet long completed the floating plant.

Equipment.—The instruments consisted of two Kern precise levels, with rods, etc., and two Price current meters, all borrowed from the Mississippi River Commission; one triangulation transit, five ordinary transits, three ordinary levels, and such lesser instruments and drafting tools necessary for a survey party. Bedding, kitchen outfit, and such other equipment as was needed were furnished from the Louisville canal depot, or by purchase.

General plan of operations.—The precise-level and base-line parties took the field on July 20 and were followed by the topographic and hydrographic party on August 1, 1911. This plan was adopted because the advance parties were placing the bench marks and computing elevations and positions thereof, which information was immediately furnished to and used by the second party. It was decided to complete the river survey first, during the favorable low-water stage, and then return to Terre Haute and begin the valley survey, which could be done at any but the highest stages, and this plan was followed as nearly as conditions permitted.

The following shows how the plan worked out: The precise-level and base-line party completed its work on December 10, 1911, and was then transformed into a topographic and hydrographic party, and took up its new work about 20 miles above the mouth, completing the stretch of the river to the mouth on January 1, 1912, about the same time that the second party finished its work to the starting point of the first party. Both parties were then towed up the river, but, owing to the freezing up of the river while en route, were obliged to retire

into winter quarters at New Harmony, 50 miles above the mouth. Four topographic parties were then made up and started on the valley survey, working in the neighborhood of the boats, which were used as a base, and as the work became too far distant to return to the boats at night, the parties boarded at farmhouses or at hotels in the small towns near their work. In this manner during two months about 200 square miles of the valley immediately above and below New Harmony, on both sides of the river, were surveyed during a very rigorous winter, marked by heavy snows and much weather below zero.

This severe weather also caused much trouble for the boats, and moving ice damaged the large quarter boat and one gasoline launch on January 23, 1912, sank the two smaller quarter boats and the supply boat. The large quarter boat and launch were readily repaired, and the better of the two smaller quarter boats, *No. 2*, was raised at small cost. Quarter boat *No. 1* and the supply boat were not recovered, and as they were not needed for the valley survey they were not replaced. Practically no equipment was lost, and the total damage amounted to about $375.

The New Harmony Harbor had hitherto been considered a good ice harbor, no damage from ice having occurred previously. Six other boats belonging to private parties were injured or destroyed there during this same period.

On March 11, 1912, the survey boats were again started up the river, reaching Terre Haute March 21. The field parties which had been kept at work while the boats were towed to Terre Haute were now recalled to the boats, but by the time of their arrival the river had risen to such a stage that no surveying was feasible. Except a few men who could be used in the office, etc., the party was therefore furloughed for about three weeks, and by that time the river had fallen sufficiently to continue the valley survey, which was accomplished without further important incident, and the remaining portion of 800 square miles was completed on September 10, 1912. The entire party was then transferred to the Ohio River survey. The final mapping of the Wabash survey was begun in the Louisville office on October 15.

Towing the boats.—The problem of towing the boats during low stages was a source of considerable trouble. The moves usually covered a stretch of about 10 miles at a time. The gasoline launches were hitched to the bow of the boats with bridle lines to assist in steering. This method was usually successful, but in many places the channel was so shallow or narrow and tortuous, and frequently even this was entirely spotted with snags, that it was impossible in such cases to move without much effort and lost time, and many times the boats were aground.

Many devices were resorted to in such cases, the capstan on the large boat being of much service, and Spanish windlasses were often necessary for the other boats. This caused considerable delay, often requiring from one-half to two days for each move. In the second trip of the party around the 10 miles of the "Old River," below New Harmony, a week was required in moving it being necessary in eight places to literally drag the boats over the bars, and in one case a temporary dike was built by sinking the six skiffs in a row and filling them with sand. By this expedient the boats which had been hard aground for 20 hours were floated across the bar in an hour's time. The gasoline launches were of no value in such cases, their power being just about enough for the purpose of steering with the current and making the landings.

Gauges.—Prior to beginning the survey in June, 1911, gauges were established at Terre Haute, Ind., Darwin, Ill., Riverton, Ind., Vincennes, Ind., St. Francisville, Grayville, and Maunie, Ill. At Grand Rapids lock and at Mount Carmel gauges already existed, and daily reports were being made. Observers were appointed for these new gauges and a daily record of stage was kept and reported. These gauges are still being maintained. The elevations of the zeros were determined by the precise-level party.

Base line.—The latitude and longitude of the United States Coast and Geodetic Survey astronomical station at Vincennes, Ind., was used for all the horizontal measurements, and although the work was carried on from Terre Haute to the mouth the computations were adjusted to fit the Vincennes station. The entire line was measured twice with a standardized 200-foot steel tape, with corrections for temperature and checked for large errors with stadia readings. The angles were read six times and the azimuth corrected by observations on polaris or 51 cephei about every 10 or 15 miles.

Reductions were made by plane triangle formulæ, and all bench-mark positions were reduced to latitude and longitude based on the Vincennes position, the fractions of minutes being given in feet instead of seconds.

From the mouth of the river the line was carried across to Wabash Island, connection being made with the Ohio River marks, and thence up to Uniontown, Ky., connecting with Geological Survey marks at that place.

Accompanying this report as Appendix C is a list of the bench marks with their descriptions, geographic position, and elevations. The final computations are on file in this office.

Precise levels.—This work was begun by two complete precise-level parties of six men each, but as the two parties kept in advance of the base-line party, quartered on the same boats, one party was temporarily transformed into a discharge party and later disbanded.

The levels were carried on under the published instructions of the Mississippi River Commission, and the outfits used were borrowed from that office. As in the case of the base line, all elevations were finally referred to the 1907 adjusted value of the United States Coast Survey bench mark A_3 at Vincennes, Ind., which is referred to mean sea level at Sandy Hook, N. J. The entire line was immediately checked by the ordinary leveling of the topographic party.

At the mouth the precise-level line was carried across the Ohio to connect with the Ohio River bench marks and thence down the Ohio River about 10 miles and, recrossing the Ohio, connected with the Geological Survey stations and the gauge at Shawneetown, Ill.

A detailed report of this work by Junior Engineer Walter P. Stewart, in subcharge, accompanies this report (Appendix F), and also a list of the descriptions and elevations of the bench marks (Appendix C).

Topography.—Topography was taken in accordance with the published instructions of the Mississippi River Commission and, in general, conformed to the written instructions of the district officer, the contour interval being 5 feet throughout. All topography was platted and sketched in the field as an aid to final mapping. All the features of the river included between levees or main high banks were surveyed on this first down trip of the boat. The river topography was begun on August 1, 1911, and completed on December 31, 1911. A list of auxiliary bench marks, marked "A," established by this party accompanies this report as Appendix E.

The valley topography was taken by four parties after the river work was completed. These parties consisted of five men each and were in the respective charge of a junior engineer and three surveyors.

Wherever practicable the work was laid out in half-mile lines normal to the stream and each party assigned to one or more of these lines, according to their lengths. As the width of the valley in some places, notably at Vincennes, was too great for a party to accomplish and return to the boat at night, it was occasionally necessary to send a party out and board them at small towns. In this way one party lived at and worked from Lawrenceburg, Ill., 12 miles west of Vincennes, for several weeks.

The total area surveyed amounted to about 775 square miles, and this was accomplished in 587 party workdays, thus making an average of 1.32 square miles per party workday.

Each party consisted of one observer, one recorder, and from three to four rodmen. The cost of such party, including subsistence, was about $20 per workday, making the cost $15.16 per square mile. With superintendence, computing, etc., this cost became $18.61, and the total, including quarter-boat charges, travel expenses, towing, etc., made the total cost about $25 per square mile. This is less than half the average total cost per square mile of similar surveys previously made on other rivers.

Hydrography.—Sounding ranges were established approximately 300 feet apart, the ends of the ranges being located by the topographic party. The soundings were taken about 40 feet apart on the ranges with a pole, except in deep water, where a lead line was used. Soundings were taken from a skiff, with two oarsmen, a leadsman, and a recorder, while the instrument man on shore located the distance to the yawl by reading a stadia board set in the bow and also kept the yawl on range. Character of the bottom and visible snags were also noted by this party. This party also set the range flags and at times assisted the topographic party in its work.

Borings.—Probings consisted of sinking a 25-foot rod to a depth of 20 feet below low water at such places designated by the district officer as probable or possible lock sites and on the bars where there was less than four feet of water. Three such probings on a range were usually taken, one being near each shore and one in the channel. The ranges for the probings at the sites were about 450 feet apart, being alternately on the sounding range and midway between sounding ranges. The character of the bottom was determined by the resistance the material offered to the driver. Sketches showing the character of bottom, the stage, the depth, etc., were made in the notebooks. A table showing the location and result of the probings accompanies this report as Appendix H.

Discharge measurements.—The river being at low-water stage, a discharge party was organized and started the measurements at Terre Haute at a zero stage on September 3, 1911. A gasoline boat was used to make the trip downstream, and measurements were taken at Vincennes, in the White River, at Mount Carmel, at New Harmony, and just below the mouth of the Little Wabash. A rise in the White River during the trip prevented the party from securing the lowest stages below that point. It was later decided that complete discharge curves from low-water to bank-full stages would be desirable and that such curves for Vincennes, Mount Carmel, and below Little Wabash River would be adequate. Such measurements were, therefore, taken at these stations as the required stages became available, but at present these curves are not completed, due to the lack of proper stages of the river.

The meters were rated in a pond near Vincennes and in the lock at Grand Rapids.

The result of these measurements are given in tabulated form herewith (Appendix H), and the discharge curves are on file in the district office, from which the discharge at any stage may be taken. Rating tables prepared from these curves are given in another part of this report.

High-water marks.—Previous to 1913 the highest waters on the Wabash were those of 1875 and of 1883; and while the former was usually considered the highest and commonly spoken of as the "August freshet," occurring as it did in the unusual month of August, still in some stretches it was found that the high water of 1883 exceeded that of 1875. All the parties were instructed to search for marks of these and other floods, and wherever an authentic mark was found its position and elevation were determined.

Since the completion of this survey another flood occurred, in April, 1913, surpassing in volume and height all preceding floods of the Wabash. A surveyor was dispatched to determine its height shortly after the water receded, and an accurate determination at about every 5 miles and at the principal towns and gauges was secured. Accompanying this report is given a tabulation of this high water, and this is likewise shown on the profile of the river.

Computations.—These were made in the field and consisted of the preliminary and final computations of the base line and of the precise level line, with the geographic positions and elevations of all bench marks. Computations for the topographic stakes, reductions of elevations of stakes, and side shots were also made in the field and partly finished, being completed later in the district office. Reductions of meter ratings and of the velocity measurements were made in the field, except those taken after the completion of the survey, which were made in the district office. Those computations not included as appendixes to this report are on file in this office.

Maps and profiles.—The maps and profiles were made in the Louisville office and consist of one set of 64 charts on a scale of 1 inch equals 400 feet, showing all the river features with about one-fourth mile of the overbank topography, and one set of 13 charts on a scale of 1 inch equals 1,600 feet, showing the river and its valley.

Profiles on a scale of 1 inch equals 4,000 feet horizontal and 1 inch equals 4 feet vertical were prepared, showing the thalweg, mean low water, highest waters, etc.

Costs.—For the character and extent of the work, the cost of this survey was remarkably small. Special attention is called to the precise levels which, at $8.90 per mile, were executed at considerably lower cost than similar work elsewhere, and the valley topography which, at $25 gross per square mile, was done at less than half the usual cost of similar work on other rivers. The following table gives the unit and total costs of the various items:

TABLE No. 1.—*Wabash River cost data.*

RIVER SURVEY.

Precise levels, 223.4 miles, at $8.89+	$1,987.14
Base line, 217.2 miles, at $9.95+	2,160.10
Shore line, 214.4 miles, at $12.61+	2,702.64
Hydrography, 214.4 miles, at $9.40+	2,014.93
Ordinary levels, 214.4 miles, at $5.85+	1,254.77
Borings, 1,854 holes, at $0.55+	1,016.52
Computing and field drafting	2,768.12
Towing	1,577.74
Gauges	1,071.60
Discharges	1,642.00
Supervision	2,492.20
Miscellaneous (including plant and equipment)	5,447.06
High-water slope, 1913	150.00
Total	26,284.82

VALLEY SURVEY.

Topography, 775 square miles, at $13.97+	$10,829.43
Computing and field drafting	923.10
Towing	1,828.83
Supervision	2,430.81
Miscellaneous	3,519.42
Topography, gross cost, 775 square miles, at $25.20+	19,531.59

PHYSICAL CHARACTERISTICS AS DETERMINED BY THE SURVEY.

General description.—The Wabash River has its source in western Ohio, flows through the State of Indiana in a southwesterly direction to a point about 15 miles below Terre Haute, and from there to its mouth forms the boundary line between Indiana and Illinois.

It drains an area of approximately 33,725 square miles, of which the White River, its principal tributary, drains about 10,780 square miles. Above Terre Haute the drainage area is about 12,200 square miles, leaving about 21,525 square miles of area for the portion of the river under consideration in this report. The mean annual rainfall is about 40 inches.

Tributaries.—The principal tributaries of the Wabash below Terre Haute are given with their drainage areas in the following table:

TABLE No. 2.—*Wabash River—Tributaries.*

Miles from mouth.	Name of river.	State.	Drainage area.
			Sq. mi.
122.1	Embarras	Illinois	2,410
95.6	White	Indiana	10,780
94.6	Patoka	do	800
15.0	Little Wabash	Illinois	3,316

River distances.—The length of the river from the highway bridge at Terre Haute to the mouth is, according to the survey of 1911, 214.37 miles. A complete table of the river distances, as determined by this survey, has been made, and the tracing is on file in the district office. The miles are also marked on the charts.

For the purpose of this report an abstract of this table, giving only the principal localities, is given below.

TABLE NO. 3.—*Wabash River—Mileage of important localities.*

Miles above mouth.	Name of place or locality.
215.0	Big Four Railroad bridge (United States gauge).
214.8	Pennsylvania Railroad bridge.
214.4	Terra Haute Highway Bridge.
199.6	State line, Illinois-Indiana.
190.0	Darwin, Ill. (United States gauge).
177.1	York, Ill.
176.3	York Cut-off.
172.5	Foot of Hutsonville Cut-off.
171.8	Hutsonville, Ill.
164.8	Merom, Ind.
162.0	Riverton, Ind., Illinois Central Railroad bridge (United States gauge).
146.9	Foot of Johnson's Cut-off.
140.3	Russellville, Ill.
128.3	Baltimore & Ohio Southwestern Railroad bridge.
127.8	Vincennes (Ind.) Highway Bridge (United States gauge).
122.1	Embarras River.
118.5	Big Four Railroad bridge (United States gauge).
115.1	St. Francisville, Ill.
109.4	Head of pool level.
105.3	Little Rock, Ind.
97.1	Grand Rapids Dam (United States gauge).
95.7	Mount Carmel, Ill. (foot of Fifth Street).
95.6	White River, Ind.
94.6	Patoka River, Ind.
94.5	Southern Railroad bridge (United States gauge).
91.5	Big Four Railroad bridge.
89.7	Head of Coffee Island.
65.2	Grayville, Ill.
63.3	Illinois Central Railroad bridge (United States gauge).
51.6	New Harmony, Ind.
51.3	Head of New Harmony Cut-off.
41.4	Foot of New Harmony Cut-off.
33.9	Maunie, Ill.
31.7	Head of Grand Chain.
30.7	Louisville & Nashville Railroad bridge (United States gauge).
25.4	Head of Little Chain.
15.0	Little Wabash River, Ill.

Cities and towns.—The following table shows the principal towns along this portion of the river and their population:

TABLE NO. 4.—*Wabash River—Cities and towns.*

Distance above mouth.	Name of town.	Population 1910.
Miles.		
214.4	Terre Haute, Ind	58,157
190	Darwin, Ill	100
177.1	York, Ill	353
171.8	Hutsonville, Ill	850
164.8	Merom, Ind	525
157.9	Palestine, Ill. (2 miles distant)	1,260
140.4	Russellville, Ill	150
127.8	Vincennes, Ind	14,895
115.4	St. Francisville, Ill	1,000
94.7	Mount Carmel, Ill. (ferry landing)	6,934
65.2	Grayville, Ill	2,000
51.6	New Harmony, Ind	1,430
33.9	Maunie, Ill	230

Grand Rapids Dam and Lock.—There is one dam with lock on the river situated about 1½ miles above Mount Carmel and known as the Grand Rapids Dam (97.1). The dam is a rock-filled, crib-sheathed structure. The lock is on the Indiana side, built of cut stone, and having concrete guide and guard walls. Both dam and lock are on rock foundation. The pool level extends

about 12.3 miles upstream. The controlling dimensions of the lock and dam are given in the table below:

Dimensions, Grand Rapids Lock and Dam.

Elevation, top of lock wall		397.116
Elevation, upper miter sill		382.036
Elevation, lower miter sill		372.116
Elevation, crest of dam		387.116
Available length of chamber	feet	214
Available width of chamber	do	52
Depth on lower miter sill at low water	do	3.20
Depth of upper miter sill	do	5.08
Length of dam		1,095.00
Lift, at low water		11.80
Elevation low water, lower gauge		375.316

NOTE.—All elevations are in feet above mean sea level at Sandy Hook. N J.

Bridges.—Eleven bridges span the Wabash between Terre Haute and the mouth, two of which are highway and the rest railroad bridges. Three of these are at Terre Haute and have no draw span. Each of the bridges below Terre Haute has a draw span.

The following table is a list of these bridges, giving their location, character, clearance, etc.:

TABLE No. 5.—*Wabash River—Bridges.*

Locality and name.	Distance from mouth.	Spans.	Total length.	Width.	Width between channel piers.	Clearance above mean low water.	Character of channel span.
	Miles.				*Feet.*	*Feet.*	
Terre Haute, Ind., Big Four R. R. bridge.	215	5	733	20	210	36.9	No draw.
Terre Haute, Ind., Pennsylvania R. R. bridge.	214.8	5	830	18	60	36.7	Do.
Terre Haute, Ind., Wabash Avenue Highway Bridge.	214.4	7	813	72	70	39.2	Do.
Riverton, Ind., Illinois Central R. R. bridge.	162	4	747	15	97	27.4	Draw.
Vincennes, Ind., B. & O. SW. R. R. bridge.	128.2	4	726	16.5	90	26.2	Do.
Vincennes, Ind., Highway Bridge.	127.8	5	778	17	60	25.5	Do.
St. Francisville, Ill., Big Four R. R. bridge (Vin. Div.).	118.5	4	728	15	100	27.1	Do.
Mount Carmel, Ill., Southern R. R. bridge.	94.5	6	1,006	23	110	31	Do.
Mount Carmel, Ill., Big Four R. R. bridge (Evans. Div.).	91.5	7	1,156	17.1	100	31.5	Do.
Grayville, Ill., Illinois Central R. R. bridge.	63.3	6	980	22	90	32.8	Do.
Maunie, Ill., L. & N. R. R. bridge.	30.8	6	1,137	15.5	100	33.3	Do.

Levees.—There are 87 miles of levee along the section of the river surveyed, of which 49 miles are on the left bank and 38 miles on the right.

These levees are from 6 to 10 feet wide on top, from 15 to 25 feet across the base, and vary in height from 8 to 16 feet, and they are usually close to the bank of the stream. Very little attention has been paid to their maintenance and crevasses caused by high water have left many broken stretches. They have been built to a height above the ordinary high water, but the flood of 1913 overtopped these levees in many places. There are no levees below Grayville, Ill. (65.)

A table giving the extent and location of the levees, their mileage and elevation in feet above sea level, is given below:

TABLE No. 6.—*Wabash River—Levees.*

Miles from mouth.		Length of stretch.[1]		Elevation.		Locality.
From mile—	To mile—	Right bank.	Left bank.	Head.	Foot.	
214.8	213.6	1.2	.....	471.4	470.6	Terre Haute.
213.4	212.2	1.2	.....	470.7	471.2	Terre Haute to Sugar Creek.
212.6	212.3	.....	0.3	465.8	.....	Opposite Sugar Creek.
212.3	211.9	.4	.....	469.7	.....	Below Sugar Creek.
211.9	211.3	.....	.6	467.8	464.1	Do.
211.2	210.3	.....	.9	461.2	458.6	
209.1	207.1	.....	2.0	464.8	462.4	
203.2	199.6	.....	3.6	467.7	464.4	Goose Nest Bar.
199.5	191.8	.....	7.7	464.9	460.1	State line to Darwin Cut-off.
192.8	192.6	.2	.....	458.4	.....	
180.0	179.5	.....	.5	451.6	.....	Above Devils Elbow.
178.3	169.7	.....	8.6	456.4	447.6	Devils Elbow to Turmans Creek.
176.9	176.7	.2	.....	450.5	.....	Below York.
173.7	173.5	.2	.....	447.5	.....	1 mile above Hutsonville Cut-off.
171.8	171.5	.3	.....	.....	.....	Below Hutsonville.
169.6	169.4	.2	.....	437.6	.....	Turmans Creek.
168.6	167.6	1.0	.....	446.9	446.2	
167.5	166.7	.8	.....	445.3	.....	
166.7	163.4	3.3	.....	445.8	440.1	Opposite Merom.
162.0	159.5	.....	2.5	444.2	442.5	Riverton to above Lamotte Creek.
156.3	152.0	.....	4.3	441.0	438.6	
143.3	130.3	13.0	.....	432.1	425.6	Below Swan Island 1 mile below Fort Knox.
142.6	136.0	.....	6.6	431.8	429.4	1 mile below Swan Island to Belgrade Landing.
129.4	123.2	6.2	.....	425.1	420.9	Kelsos Creek to 1 mile above Embarras River.
127.5	118.1	.....	9.4	422.7	417.5	Vincennes to Big Four Railroad bridge.
97.5	97.2	.....	.3	402.1	.....	Above Grand Rapids Dam.
88.8	86.5	2.3	.....	396.3	395.4	Below Rochester.
84.9	84.1	.8	.....	393.4	392.0	Crowleyville.
79.3	77.4	1.9	.....	391.1	390.6	McClearys Bluff.
77.0	76.6	.4	.....	388.5	.....	
76.2	75.7	.....	.5	388.5	.....	
72.5	67.9	4.6	.....	390.9	386.2	Pearl Island to 1 mile above Kingdom Island.
67.4	66.4	.....	1.0	387.0	338.0	Kingdom Island.
		38.2	48.8			
		48.8				
		87.0				

[1] Miles.

Snags.—The Wabash River is badly obstructed by snags from Terre Haute to Vincennes and comparatively free from them below there. An estimate based on the snags visible during the operations of sounding the river places the total number of snags of various sizes at 2,000, or an average of 9.3 per mile, of which number 1,685, or 14.1 per mile, are located above Mount Carmel (95). These snags are most commonly found in clusters, and in such cases, at low stages, make navigation quite impossible, even where the depth of water would otherwise suffice for navigation.

Timber and willows.—Overhanging trees along this stretch of the river are not numerous, and such as do exist (about 35 miles) have little tendency to interfere with navigation or landings at ordinary stages.

There are about fifty localities along the banks at which willows of various sizes grow, principally on the points and towheads. These stretches contain from 2 to 250 acres each, or a total of 1,187 acres. Only a small percentage of these willows, probably less than 150 acres, are sufficiently straight and supple and of proper length and thickness to be available for the purpose of mattress work for revetments.

Gauges and stages.—The stage of the Wabash River has a range from low to high water varying from 22.1 feet at St. Francisville, Ill., to 54.9 feet at its

mouth. The following table gives a list of the gauges along the Wabash with the values of their zeros, mean low water, mean stage, bank-full stage, highest known water (1913), and range of stage:

TABLE NO. 7.—*Wabash River—Stages.*

Distance from mouth.	Locality.	Elevation, zero of gauge.	Gauge reading.				Range of stage.
			Mean low water.	Mean stage.	Bank full stage.	High water 1913.	
Miles.							
214.4	Terre Haute, Ind	447.11	0.00	3.2	16.0	31.20	31.2
190.0	Darwin, Ill	431.55	.80	5.4	15.0	27.30	26.5
162.0	Riverton, Ind	415.90	1.20	5.3	14.0	26.80	25.6
127.8	Vincennes, Ind	397.66	.46	4.2	14.0	24.00	23.6
118.5	Above St. Francisville	391.00	1.50	5.3	13.0	23.60	22.1
94.5	Mount Carmel, Ill	372.63	.73	6.3	19.0	30.42	29.7
63.3	Below Grayville, Ill	357.88	.00	6.1	17.0	29.37	29.4
30.7	Below Maunie, Ill	340.63	.70	6.5	14.0	32.87	32.2
0.0	Mouth (Ohio)[1]	314.90	.00	16.9	25.0	54.85	54.9

[1] There is no gauge at the mouth, but the values given are taken above mean low water, which is assumed as the zero of a tentative gauge, and were derived from the Ohio River stages.

Extreme low water on the Wabash is, generally speaking, about 1 foot lower than mean low water, the records for Terre Haute showing the amount to have been 1.2 feet in 1904, and at Mount Carmel 0.9 foot in 1895. High waters occurred in the following years and are given in the order of their height: 1913, 1875, 1883, 1904, 1898, 1893, 1907, 1897, and 1882. The following table gives the elevations of the flood of 1913 for about each 5 miles of river:

TABLE NO. 8.—*Wabash River—High-water marks, 1913.*

Miles above mouth of river.	Locality.	Date.	Elevation.	Gauge reading.
215.0	Big Four R. R. bridge; T. H. gauge	Mar. 27	478.31	31.2
214.4	Terre Haute; wagon bridge	...do	478.30	
209.0			473.18	
204.4		Mar. 27	470.24	
199.9	Honey Creek		465.01	
194.0	Head Darwin Cut-off		459.91	
190.0	Darwin (Ill.) gauge	Mar. 28	458.85	27.3
184.6	Head of Chenoweths Reach	...do	457.56	
177.1	York Ferry	Mar. 27	451.77	
174.4	Rock Bar	Mar. (?)	450.90	
171.8	Hutsonville Ferry	Mar. 28	448.38	
164.8	Merom Ferry	Mar. 27	444.80	
162.0	Illinois Central R. R. bridge; Riverton gauge	...do	442.70	26.8
157.9	Palestine Landing; ferry	...do	440.41	
153.8	Hites Ferry (abandoned)	Mar. 28	437.66	
148.1	Longtown Landing; Chambers Ferry	...do	434.01	
143.1			432.32	
140.3	Russellville, Ill	Mar. 28	430.54	
135.9	Above Belgrade Landing		428.91	
131.4			425.49	
127.8	Wagon bridge; Vincennes gauge	Mar. 29	421.66	24.0
123.6		...do	419.51	
118.5	Big Four R. R. bridge; St. Francisville gauge	Mar. 30	414.60	23.6
115.1	St. Francisville Ferry	...do	413.40	
112.1		...do	413.04	
107.6		...do	411.37	
101.8	Buchanans Ferry; Patton Station	...do	407.41	
97.1	Grand Rapids Lock and Dam, gauge	Mar. 31	405.21	[1] 23.34 [2] 33.25
94.5	Southern R. R. bridge; Mount Carmel gauge	Mar. 29	403.05	30.5
91.5	Big Four R. R. bridge	Mar. 31	400.51	
84.5	Crowleyville, Ind	Mar. 29	394.60	
78.0			392.54	

[1] Upper. [2] Lower

TABLE No. 8.—*Wabash River—High-water marks, 1913*—Continued.

Miles above mouth of river.	Locality.	Date.	Elevation.	Gauge reading.
75.0	.....	Mar. 30	390.79	.....
69.1	.....	...do.....	389.47	.....
63.3	Illinois Central R. R. bridge; Grayville gauge.....	Mar. 31	387.25	29.4
58.4	.....	...do.....	383.79	.....
55.4	Mouth of Black River.....	.....	383.57	.....
51.6	New Harmony; ferry.....	Mar. 30	382.08	.....
45.3	Hodges Landing.....	.....	378.25	.....
42.2	Old River.....	.....	378.67	.....
39.4	Foot Mink Island.....	Mar. 30	377.95	.....
33.9	Maunie.....	Mar. 31	375.30	.....
30.7	Louisville & Nashville bridge; Maunie gauge.....	...do.....	373.50	32.9
26.0	Head Little Chain Cut-off.....	.....	370.69	.....
22.2	Fretageots Ferry.....	.....	370.50	.....
15.0	Little Wabash River.....	.....	370.13	.....
.....	New Haven (Little Wabash River).....	Apr. 3	370.58	.....
10.6	Mile above Bone Bank.....	Apr. 5	370.54	.....
6.5	.....	.....	369.43	.....
3.1	Below Skidmore Bar.....	.....	369.98	.....
[1] 0.5	Wabash Island, opposite mouth of Wabash River.....	.....	369.75	.....
[1] 42.1	In New Harmony Cut-off.....	.....	378.92	.....

[1] Below mouth.

The readings for all the gauges since their establishment, in June, 1911, have been tabulated on tracings and are on file in the district office. These readings have been supplemented by the addition of such readings at the stations prior to the above date as are recorded by the United States Weather Bureau. The stages of the two gauges at the Grand Rapids Lock since 1899 are also on file.

Duration of stages.—At Terre Haute (214), Vincennes (128), Mount Carmel (95), and the mouth sufficient records are available to determine with a fair degree of accuracy the mean annual duration of stages of the river, and tables have been prepared for these four stations showing the annual duration for each foot of the gauge and also for each foot above mean low water. The duration curves have also been platted and are on file in the district office.

An inspection of the tables shows that the river is below mean low water annually for 41 days at Terre Haute, 24 days at Vincennes, 22 days at Mount Carmel, and 3 days at the mouth. A stage of 4 feet above mean low water would give a navigable depth of 6 feet throughout the river, except through the 10 miles of the "Old River" immediately below New Harmony, and this stage or higher exists for 133 days at Terre Haute and Vincennes, for 168 days at Mount Carmel, and for 318 days at the mouth. Stages above bank full occur from one to three times each year, and their total annual duration amounts to about 14 days, except near the lower end, where, due to the Ohio, the flood stages exist for about 50 days annually. The "Old River" below New Harmony has a least depth of 6 feet only when the stage of river at that town is 8 feet above mean low water, or the Grayville gauge, 13 miles above, reads about 9 feet. This stage occurs for about 75 days annually. For a 4-foot depth the "Old River" would be navigable for about 105 days annually. The New Harmony cut-off is safely navigable at stages above 12 feet above mean low water, or during a mean annual period of 53 days. It is not navigable below that stage, owing to an abrupt fall of about 4 feet over the rough rocks at its lower end.

This condition in the "Old River" was brought about, it is believed, by the large amount of drainage work done in the Wabash Basin in recent years, and also by a filling up of the "Old River" as the cut-off has gradually widened, the latter receiving a steadily increasing increment of the discharge which formerly went down the old channel. This is, therefore, the most important obstruction to navigation in the Wabash, viz, a cut-off navigable only at stages above 12 feet and the "Old River" navigable only above 6 feet, so that during more than eight months in an average year a boat of 3-foot draft can not ascend the river from its mouth to Terre Haute.

The following tables give the stage duration at Terre Haute, Vincennes, Mount Carmel, and the mouth:

TABLE No. 9.—*Wabash River—Duration of stages.*

TERRE HAUTE, IND. (214).

Gauge reading.	Number of days.	At or above mean low water.	Number of days.	Gauge reading.	Number of days.	At or above mean low water.	Number of days.
— 1.0	364.3	— 1.0	364.3	[3] 16.0	15.0	16.0	15.0
[1] 0.0	324.0	[1] 0.0	324.0	17.0	11.1	17.0	11.1
1.0	254.2	1.0	254.2	18.0	7.6	18.0	7.6
2.0	204.4	2.0	204.4	19.0	5.1	19.0	5.1
3.0	165.7	.....	165.7	20.0	3.2	20.0	3.2
[2] 3.2	158.0	.....	.....	21.0	1.8	21.0	1.8
4.0	133.1	4.0	133.1	22.0	1.0	22.0	1.0
5.0	107.8	5.0	107.8	23.0	.8	23.0	.8
6.0	90.8	6.0	90.8	24.0	.7	24.0	.7
7.0	76.2	7.0	76.2	25.0	.6	25.0	.6
8.0	64.8	8.0	64.8	26.0	.5	26.0	.5
9.0	55.5	9.0	55.5	27.0	.4	27.0	.4
10.0	47.3	10.0	47.3	28.0	.3	28.0	.3
11.0	40.6	11.0	40.6	29.0	.2	29.0	.2
12.0	34.2	12.0	34.2	30.0	.1	30.0	.1
13.0	28.7	13.0	28.7	31.0	.05	31.0	.05
14.0	23.8	14.0	23.8	31.2	.0	31.2	.0
15.0	19.2	15.0	19.2	[4] 31.21	.....	.....	.....

[1] Mean low water. [2] Mean stage. [3] Bank full. [4] 1913.

Elevation, zero of gauge=447.10 feet. Mean low water reads zero on gauge.
Extreme low water = — 1.2, Dec. 18–22, 1904.
Extreme high water = 31.21, Mar. 27, 1913.

NOTE.—Columns 1 and 2 give the duration for each foot on the gauge, columns 3 and 4 for mean low water and each foot above. Extreme stages are also given. The number of days corresponding to any stage is the average number of days annually that the height of the river is at or above that stage.

TABLE No. 10.—*Wabash River—Duration of stages.*

VINCENNES, IND. (128).

Gauge reading.	Number of days.	At or above mean low water.	Number of days.	Gauge reading.	Number of days.	At or above mean low water.	Number of days.
— 1.0	365.0	— 1.0	365.0	12.0	36.3	12.0	32.7
.0	362.6	[1] .0	341.4	13.0	29.0	13.0	26.3
[1] .7	341.4	.....	.....	[3] 14.0	22.9	14.0	20.3
1.0	306.5	1.0	282.0	15.0	17.2	15.0	14.5
2.0	253.8	2.0	242.0	16.0	12.4	16.0	10.7
3.0	197.3	3.0	170.5	17.0	8.0	17.0	7.1
4.0	149.0	4.0	132.5	18.0	5.5	18.0	3.6
[2] 4.2	140.0	.....	.....	19.0	2.3	19.0	2.0
5.0	118.2	5.0	107.8	20.0	1.4	20.0	1.6
6.0	98.2	6.0	91.7	21.0	1.0	21.0	1.1
7.0	85.0	7.0	78.2	22.0	.7	22.0	.6
8.0	73.0	8.0	67.8	23.0	.3	23.0	.2
9.0	62.4	9.0	52.5	24.0	.....	24.0	.....
10.0	53.0	10.0	48.0	[4] 24.0	.....	.....	.....
11.0	43.9	11.0	40.5				

[1] Mean low water. [2] Mean stage. [3] Bank full. [4] 1913.

Elevation of zero of gauge = 397.66 feet.
Mean low water reads 0.46 on gauge.
Extreme low water = 0.1 Nov. 10, 1887.
Extreme high water = 24.0 Mar. 29, 1913.

NOTE.—Columns 1 and 2 give the duration for each foot on the gauge, columns 3 and 4 for mean low water and each foot above. Extreme stages are also given. The number of days corresponding to any stage is the average number of days annually that the height of the river is at or above that stage.

TABLE NO. 11.—*Wabash River—Duration of stages.*

MOUNT CARMEL, ILL. (95).

Gauge reading.	Number of days.	At or above mean low water.	Number of days.	Gauge reading.	Number of days.	At or above mean low water.	Number of days.
— 0.2	365.0	— 0.9	365.0	14.0	37.2	14.0	33.8
.0	363.2	[1] 1.0	343.3	15.0	33.3	15.0	28.9
[1] .73	343.3	.....	.....	16.0	27.5	16.0	24.4
1.0	330.6	1.0	299.0	17.0	23.0	17.0	20.0
2.0	282.5	2.0	247.0	18.0	18.5	18.0	16.2
3.0	235.8	3.0	207.1	[3] 19.0	14.8	19.0	12.3
4.0	194.0	4.0	168.0	20.0	11.8	20.0	8.5
5.0	157.5	5.0	137.0	21.0	7.8	21.0	6.5
6.0	130.0	6.0	114.0	22.0	6.0	22.0	4.2
[2] 6.3	123.5	.....	.....	23.0	3.7	23.0	2.2
7.0	108.0	7.0	96.1	24.0	2.1	24.0	1.8
8.0	91.5	8.0	82.0	25.0	1.7	25.0	1.5
9.0	78.0	9.0	71.8	26.0	1.2	26.0	.9
10.0	68.0	10.0	62.2	27.0	.7	27.0	.4
11.0	59.2	11.0	53.3	28.0	.2	27.6	.....
12.0	51.7	12.0	45.8	[4] 28.3	.....	.....	.....
13.0	43.5	13.0	38.7	[5] 29.65	.....	.....	.....

[1] Mean low water. [2] Mean stage. [3] Bank full. [4] 1875. [5] 1913.

Elevation of zero of gauge = 372.67 feet.
Mean low water reads 0.73 on gauge.
Extreme low water = — 0.2 Nov. 7–23, 1895.
Extreme high water = 29.65 Mar. 29, 1913.

NOTE.—Columns 1 and 2 give the duration for each foot on the gauge, columns 3 and 4 for mean low water and each foot above. Extreme stages are also given. The number of days corresponding to any stage is the average number of days annually that the height of the river is at or above that stage.

TABLE NO. 12.—*Wabash River—Duration of stages.*

MOUTH.

At or above mean low water.	Number of days.	At or above mean low water.	Number of days.	At or above mean low water.	Number of days.	At or above mean low water.	Number of days.
—1.3	365.0	14.0	157.2	28.0	61.5	43.0	14.4
[1] 0.0	362.0	15.0	146.9	29.0	58.3	44.0	11.7
1.0	353.7	16.0	137.5	30.0	55.1	45.0	8.9
2.0	342.7	[2] 16.9	129.8	31.0	51.7	46.0	6.4
3.0	330.8	17.0	128.5	32.0	48.4	47.0	4.9
4.0	318.4	18.0	119.6	33.0	45.2	48.0	3.6
5.0	300.0	19.0	111.2	34.0	41.9	49.0	2.5
6.0	281.8	20.0	103.1	35.0	38.5	50.0	1.7
7.0	262.6	21.0	96.0	36.0	35.2	51.0	0.9
8.0	245.7	22.0	89.5	37.0	32.3	52.0	0.5
9.0	226.1	23.0	81.6	38.0	29.0	53.0	0.1
10.0	209.2	24.0	78.3	39.0	25.9	[4] 53.55	0.0
11.0	194.8	[3] 25.0	73.5	40.0	22.9	[5] 54.85	.....
12.0	181.0	26.0	69.2	41.0	20.0		
13.0	168.6	27.0	63.3	42.0	17.2		

[1] Mean low water. [2] Mean stage. [3] Bank full. [4] 1884. [5] 1913.

Extreme low water = — 1.3 below mean low water Nov. 7-8, 1895.
Extreme high water = 54.85 above mean low water Apr. 5, 1913.

NOTE.—The number of days corresponding to any stage is the average number of days annually that the height of the river is at or above that stage.

Extent of Ohio backwater.—The Ohio River has considerable influence on the lower Wabash, and at very high stages in the Ohio it has a tendency to back up the water as far as New Harmony, 50 miles above the mouth of the Wabash. This occurs only when the Ohio is at a flood stage and the Wabash is at stages below 20 feet. Below is given a table showing how many miles up the Wabash each foot of stage of the Ohio would reach in seeking its level, assuming the

Wabash to be at mean low-water stage. These extreme conditions never actually occur at the same time, as high stages are generally coincident in the two rivers.

This table shows that the pool of the proposed dam, No. 50, on the Ohio below the mouth of the Wabash is about 6 feet above mean low water at the mouth, and its influence at low water would extend but 3.5 miles upstream. The table also shows that the Ohio high water of 1913 would meet the level of the Wabash when at mean low water, 88 miles above its mouth.

TABLE No. 13.—*Wabash River—Extent of Ohio backwater.*

Heights above mean low water in Ohio River.	Elevation of same.	Extent of backwater in miles above mouth at low water in Wabash.	Vicinity of—
0.0	314.9	0.0	Mouth of Wabash River.
1.0	315.9	0.56	
2.0	316.9	1.07	
3.0	317.9	1.74	
4.0	318.9	2.37	
5.0	319.9	2.89	
[1]5.9	320.8	3.47	Skidmores Bar.
6.0	320.9	3.52	
7.0	321.9	4.30	
8.0	322.9	5.08	Running Slough R. B.
9.0	323.9	6.02	
10.0	324.9	6.91	
11.0	325.9	7.76	Head Mackeys Island.
12.0	326.9	8.94	Bone Bank Lower End.
13.0	327.9	10.43	
14.0	328.9	11.89	
15.0	329.9	13.08	
16.0	330.9	13.97	1 mile below Little Wabash River.
17.0	331.9	15.69	
18.0	332.9	17.01	
19.0	333.9	17.63	
20.0	334.9	18.80	
21.0	335.9	20.07	
22.0	336.9	23.35	¼ mile above foot of Little Chain Cut-off.
23.0	337.9	24.79	
24.0	338.9	25.50	Head Little Chain Cut-off.
25.0	339.9	26.75	
26.0	340.9	29.29	Marshalls Island, foot.
27.0	341.9	31.16	Grand Chain, foot.
28.0	342.9	31.30	
29.0	343.9	31.50	
30.0	344.9	31.74	Grand Chain, head.
31.0	345.9	34.54	
32.0	346.9	37.42	Twin Sister Island, No. 2, head.
33.0	347.9	40.83	½ mile below foot of New Harmony Cut-off.
34.0	348.9	43.73	
35.0	349.9	46.21	1 mile above Hodges Landing.
36.0	350.9	47.21	
37.0	351.9	48.56	
38.0	352.9	49.63	
39.0	353.9	50.03	Warty Black Towhead, Head.
40.0	354.9	51.56	New Harmony.
41.0	355.9	54.66	
42.0	356.9	58.97	1 mile above Big Bayou.
43.0	357.9	63.29	Illinois Central R. R. bridge.
44.0	358.9	66.30	Kingdom Island, foot.
45.0	359.9	68.22	½ mile below Johnsons Ferry.
46.0	360.9	70.08	
47.0	361.9	71.69	1 mile below Foot Pearl Island.
48.0	362.9	73.29	
49.0	363.9	74.90	
50.0	364.9	76.62	
51.0	365.9	79.30	McClearys Bluff, foot.
52.0	366.9	80.44	
53.0	367.9	82.18	
[2]53.55	368.4	83.58	¼ mile above Jimtown.
[3]54.85	369.75	87.90	¾ mile below Rochester.

[1] Pool Level Dam No. 50 (Ohio River.) [2] High water 1884. [3] High water 1913.

NOTE.—In this table the Wabash River is assumed to be at mean low stage. The Ohio stages, columns 1 and 2, would then extend up the Wabash, seeking their level, the number of miles in column 3.

Discharge.—The discharge of the Wabash has been determined in part at Terre Haute, Vincennes, Mount Carmel, and below the Little Wabash. The following table gives the approximate values at these stations for mean low water, mean and bank-full stages:

TABLE No. 14.—*Wabash River—Result of discharge observations.*

Locality.	Mean low water.	Mean stage.	Bank full.
	Sec.-feet.	*Sec.-feet.*	*Sec.-feet.*
Terre Haute (214)	1,890	[1] 5,900	[1] 43,700
Vincennes (128)	2,000	9,500	40,000
Mount Carmel (95)	2,500	21,000	80,000
Mouth of Little Wabash (15)	2,800	[2] 32,000	85,000

[1] United States Geological Survey. [2] Mean stage derived from Maunie gauge.

Results of all the discharge measurements taken are tabulated for each station and given as Appendix I to this report.

Discharge curves have been constructed and rating tables for Vincennes, Mount Carmel, and below mouth of Little Wabash, are submitted as follows:

TABLE No. 15.—*Wabash River—Rating table.*

VINCENNES, IND. (128).

Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
0.0	1,700	6.5	16,150	13.0	37,000	19.5	73,000
.5	2,100	7.0	17,700	13.5	38,600	20.0	77,300
1.0	2,600	7.5	19,300	14.0	40,200	20.5	81,600
1.5	3,300	8.0	20,850	14.5	41,800	21.0	85,900
2.0	4,200	8.5	22,400	15.0	43,400	21.5	90,200
2.5	5,250	9.0	24,000	15.5	45,100	22.0	94,600
3.0	6,400	9.5	25,600	16.0	47,050	22.5	98,900
3.5	7,700	10.0	27,200	16.5	49,400	23.0	103,300
4.0	9,000	10.5	28,800	17.0	52,500	23.5	107,600
4.5	10,350	11.0	30,450	17.5	56,200	24.0	111,900
5.0	11,800	11.5	32,100	18.0	60,100		
5.5	13,250	12.0	33,750	18.5	64,400		
6.0	14,700	12.5	35,400	19.0	68,700		

NOTE.—Above gauge height 19 feet the rating curve is produced as a tangent. Zero of gauge is 397.66 feet above mean sea level. Mean low water reads 0.46 feet on gauge.

TABLE No. 16.—*Wabash River—Rating table.*

MOUNT CARMEL, ILL. (95).

Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
0.0	2,200	8.0	28,300	16.0	62,600	24.0	188,400
.5	2,700	8.5	30,400	16.5	64,900	24.5	203,700
1.0	3,500	9.0	32,500	17.0	67,200	25.0	219,000
1.5	4,400	9.5	34,650	17.5	69,600	25.5	234,300
2.0	5,500	10.0	36,800	18.0	72,200	26.0	249,700
2.5	6,700	10.5	38,950	18.5	75,100	26.5	265,200
3.0	8,200	11.0	41,100	19.0	78,700	27.0	280,700
3.5	9,800	11.5	43,250	19.5	83,300	27.5	296,200
4.0	11,600	12.0	45,400	20.0	89,700	28.0	311,700
4.5	13,500	12.5	47,550	20.5	97,200	28.5	327,000
5.0	15,400	13.0	49,700	21.0	107,400	29.0	342,300
5.5	17,500	13.5	51,850	21.5	119,600	29.5	357,600
6.0	19,700	14.0	54,000	22.0	131,800	30.0	372,900
6.5	21,850	14.5	56,150	22.5	144,000	30.4	385,000
7.0	24,000	15.0	58,300	23.0	158,500		
7.5	26,150	15.5	60,450	23.5	173,100		

NOTE.—Above gauge height 28 feet the rating curve is produced as a tangent. Values below 2 feet are approximate. Zero of gauge is 372.63 feet above mean sea level. Mean low water reads 0.73 feet on gauge.

TABLE No. 17.—*Wabash River—Rating table.*

BELOW MOUTH OF LITTLE WABASH RIVER (15).

Height above mean low water.	Discharge.	Height above mean low water.	Discharge.	Height above mean low water.	Discharge.	Height above mean low water.	Discharge.
Feet.	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*
−1.0	1,100	3.5	17,200	8.0	39,280	12.5	64,300
− .5	1,800	4.0	19,375	8.5	42,060	13.0	67,090
.0	2,800	4.5	21,550	9.0	44,840	13.5	69,870
.5	4,300	5.0	23,725	9.5	47,620	14.0	72,650
1.0	6,325	5.5	25,900	10.0	50,400	14.5	75,430
1.5	8,500	6.0	28,300	10.5	53,180	15.0	78,210
2.0	10,675	6.5	30,900	11.0	55,960	15.5	81,000
2.5	12,850	7.0	33,700	11.5	58,740	16.0	83,790
3.0	15,025	7.5	36,500	12.0	61,620		

NOTE.—There is no gauge at this station. The heights are taken above mean low water, the elevation of which is 331.5. Values below 2 and above 10 feet are interpolated and are therefore approximate.

Banks—The banks of the Wabash are principally of a light sandy loam and in some cases sand and clay. Except for a few small stretches the banks are generally low, the average height (between Terre Haute and the mouth) of the right bank being 13.9 feet, and of the left bank 14.1 feet, above mean low water.

The following table shows the mean heights above mean low water of the banks on each side, for stretches of 10 miles from the mouth up, and also gives the mean sea level elevations.

TABLE No. 18.—*Wabash River—Bank heights.*

Locality.	Distance from mouth.		Elevation of mean low water.	Average elevation of bank.		Average height of bank above mean low water.	
	From mile—	To mile—		Left bank.	Right bank.	Left bank.	Right bank.
Sugar Creek	214.4	210	445.4	459.8	458.8	14.4	13.4
Eight Mile Island	210.0	200	442.5	455.8	454.3	13.3	11.8
Big Creek	200.0	190	436.9	449.9	448.9	13.0	12.0
Chenoweths Reach	190.0	180	430.0	443.3	444.2	13.3	14.2
Raccoon Creek	180.0	170	424.9	437.5	437.1	12.6	12.2
Merom	170.0	160	418.9	431.4	431.7	12.5	12.8
Little Creek	160.0	150	413.1	425.6	425.3	12.5	12.2
Buck Creek	150.0	140	407.0	419.3	419.7	12.3	12.7
Seven Mile Island	140.0	130	400.8	414.0	413.7	13.2	12.9
Vincennes	130.0	120	396.3	409.6	408.2	13.3	11.9
St. Francisville	120.0	110	390.7	401.4	401.0	10.7	10.3
River Desher	110.0	105	387.7	396.8	398.2	9.1	10.5
Pool formed by Grand Rapids Dam	105.0	100	387.3	397.6	397.2	10.3	9.9
	100.0	97	387.3	395.7	394.3	8.4	7.9
Patoka Island	97.0	90	373.1	389.5	389.8	16.4	16.7
Crowleyville	90.0	80	368.9	385.6	385.3	16.7	16.4
Peankishaw Bend	80.0	70	363.8	378.8	379.2	15.0	15.4
Grayville	70.0	60	358.7	374.5	374.1	15.8	15.4
Black River	60.0	50	355.7	370.4	369.2	14.7	13.5
Hodges Landing	50.0	40	349.9	364.5	364.5	14.6	14.6
Maunie	40.0	30	345.5	360.0	360.0	14.5	14.5
Little Chain	30.0	20	338.5	355.2	353.1	16.7	14.6
Little Wabash	20.0	10	331.6	347.2	347.4	15.6	15.8
Mackeys Island	10.0	0	322.2	342.7	343.5	20.5	21.3
Mean	.....	.....	.....	.....	.....	14.1	13.9

NOTE.—In determining the above bank heights small stretches of unusually high, bluff-banks and small low areas on the points, were omitted.

There are many miles of caving banks on the Wabash, but the amount thus eroded is not excessive as compared with other alluvial streams. This process of cutting away of the bank is very gradual and seldom exceeds 20 feet per annum. As in all streams these caving banks are usually in the bends where the current is swift and the river deep, and the opposite points are made out about as rapidly as the banks cave, thus maintaining the normal width of the stream. Altogether there are 68 miles of caving banks, of which amount 39 miles are on the right bank and 29 miles on the left.

Following is a table showing the location and extent of the caving banks between Terre Haute and the mouth:

TABLE No. 19.—*Wabash River—Caving banks.*

Locality.	Miles from mouth.		Length of stretch.		Remarks.
	From mile—	To mile—	Right bank.	Left bank.	
Below Terre Haute	212.5	212.0	.....	0.5	Levee joining above and below.
Do	211.6	210.2	1.4	.....	High, badly caving.
Do	210.2	209.8	.....	.4	Do.
Do	207.5	207.1	.4	.....	High bank joining above.
Below Sharps Ferry	205.4	204.6	.8	.....	
Below State line	199.4	198.1	1.3	.....	Partly timbered, slowly caving.
Below Darwin Ferry	189.4	188.3	.....	1.1	
Bowen Ferry	188.3	187.8	.5	.....	
Above Prevosts Ferry	187.7	187.3	.....	.4	
Below Prevosts Ferry	187.2	186.5	.7	.....	Badly caving.
Do	186.5	186.3	.....	.2	
Little Sycamore Bend	186.1	185.2	.....	.9	Do.
Chenoweths Reach	184.8	184.4	.4	.....	
Do	182.9	182.0	.....	.9	
Above Niles Landing	182.0	181.6	.4	.....	
Below Niles Landing	181.4	180.9	.....	.5	
Do	180.8	180.2	.6	.....	
Do	180.2	180.0	.....	.2	
Above Devils Elbow	179.4	178.4	1.0	.....	Partly timbered, cultivated portion badly caving.
Below Devils Elbow	178.1	177.8	.....	.3	
York Cut-off	176.9	176.4	.5	.....	
Below York Cut-off	176.3	175.8	.....	.5	
Do	175.8	175.5	.3	.....	
Do	173.9	173.6	.3	.....	
Hutsonville Cut-off	173.5	172.6	.....	.9	Badly caving.
Do	172.6	172.5	.1	.....	
Do	172.5	172.3	.....	.2	
Below Turmans Creek	169.4	168.7	.....	.7	
Greers Ripple	160.5	159.7	.8	.....	
Do	159.6	158.7	.....	.9	
Above Lamotte Creek	158.6	158.2	.4	.....	
Do	157.0	156.6	.4	.....	Slightly caving.
Do	152.6	152.1	.5	.....	
Do	152.1	151.9	.....	.2	
Do	151.6	151.3	.3	.....	
Do	151.3	150.9	.....	.4	
Do	150.9	150.4	.5	.....	
Do	150.4	150.1	.....	.3	
Do	150.1	149.3	.8	.....	
Below Little Busseron Creek	149.2	148.1	.....	1.1	
Do	147.8	147.6	.2	.....	
Above Johnsons Ripple	147.2	146.9	.....	.3	
Below Johnsons Ripple	146.9	146.7	.2	.....	
Do	145.2	144.9	.....	.3	
Swan Island	143.7	143.0	.7	.....	
Below Seven-mile Island	133.4	132.8	.6	.....	
Above Fort Knox	132.0	131.5	.5	.....	
Do	120.3	120.0	.3	.....	
Do	117.1	116.7	.....	.4	Badly caving.
Above McClearys Bluff	80.9	80.0	.9	.....	
Peankishaw Bend	74.0	71.9	2.1	.....	Do.
Do	71.0	69.8	1.2	.....	
Do	69.8	69.0	.....	.8	
Below Johnsons Ferry	68.6	68.0	.6	.....	
Do	68.0	67.1	.....	.9	Do.
Kingdom Island	66.9	66.5	.4	.....	
Below Kingdom Island	66.3	65.9	.....	.4	
Do	64.1	63.4	.....	.7	Do.

TABLE No. 19.—*Wabash River—Caving banks*—Continued.

Locality.	Miles from mouth.		Length of stretch.		Remarks.
	From mile—	To mile—	Right bank.	Left bank.	
French Creek	62.4	61.4	1.0	.....	
Big Bayou	58.5	57.5	.....	1.0	
Below Fox River	57.3	55.8	1.5	.....	Badly caving.
Below New Baltimore	55.8	53.7	.....	2.1	Do.
Above New Harmony	52.7	51.6	1.1	.....	
New Harmony	51.6	51.2	.....	.4	
In New Harmony Cut-off	43.6	42.5	1.1	.....	
Do	42.8	42.4	.....	.4	
Below mouth New Harmony Cut-off, in old channel.	51.2	51.0	.....	.2	
Maunie	34.9	32.8	2.1	.....	
Do	30.1	29.8	.3	.....	
Do	27.1	25.6	.....	1.5	
Below Little Chain Cut-off	23.5	23.2	.3	.....	
Do	23.2	22.3	.....	.9	Do.
Below Fretageots Ferry	22.3	21.4	.9	.....	
Do	21.4	19.8	.....	1.6	
Do	20.3	19.8	.5	.....	
Do	19.3	18.0	1.3	.....	
Do	18.0	16.9	.....	1.1	
Do	16.4	15.0	1.4	.....	Do.
Below Little Wabash River	14.6	14.2	.4	.....	
Above Parkers Landing	13.7	12.7	.....	1.0	
Do	12.1	10.0	2.1	.....	
Bone Bank and below	9.6	6.2	.....	3.4	High bank, badly caving.
Mackeys Island	7.8	7.1	.7	.....	
Above Skidmores Bar	6.3	3.7	2.6	.....	
Skidmores Bar and below	3.1	1.6	1.5	.....	Badly caving.
Above mouth	1.1	0.0	.....	1.1	Do.

River bed.—The bed of the Wabash consists principally of sand grading from fine sand to small gravel, gravel, and solid rock. A few small stretches are composed of mud and clay.

The proportion of each of these constituents is as follows:

	Miles.
Sand	103.1
Sand and gravel mixed	88.2
Gravel	17.7
Bedrock	5.4

The sand in the Wabash is clean and sharp; the gravel grades from fine to coarse, and both are excellent for concrete work. On account of its whiteness it is much used for fine building purposes in preference to the redder sand and gravel of the Ohio. Very little of the gravel would be retained on a 2-inch mesh. The gravel and coarser sand beds of the Wabash are comparatively stable, but the finer sand moves easily with the varying stages and currents of the river.

Besides the exposed rock given in the above table, probings were made to a depth not exceeding 20 feet below low water in certain localities believed to be possible dam sites, and showed an additional amount of nearly 20 miles of bedrock and about 1½ miles more in the New Harmony cut-off, thus making a total of 26.6 miles of bedrock in the 214 miles, at a depth of 20 feet.

The following table shows the location, length, and depth below low water of the principal stretches of bedrock:

TABLE No. 20.—*Wabash River—Bed-rock stretches.*

Locality.	Distance from mouth.		Length of stretch.	Average width of river at mean low water.	Average depth of rock below mean low water.	Remarks.
	From mile—	To mile—				
			Feet.	*Feet.*	*Feet.*	
Niles Ferry	181.4	181.3	800	380	6.3	
Raccoon Creek	174.5	174.2	1,600	300	8.0	
Palestine Landing	158.0	157.1	4,700	400	3.7	
Longtown Landing	147.9	147.6	1,400	320	6.1	
Swan Island	144.0	143.5	2,700	430	2.0	
	132.5	132.2	1,500	420	4.7	
Fort Knox, Vincennes	131.6	128.6	15,800	620	5.5	
Big Four R. R. bridge, St. Francisville	119.4	118.3	5,800	550	3.5	
	118.0	117.7	1,300	440	7.0	
St. Francisville	115.3	114.1	6,000	630	4.4	
Poker Creek	110.9	109.4	7,800	660	2.8	
Little Rock post office	106.5	105.2	6,900	890	2.9	
	103.5	103.0	2,900	920	4.9	Probably rock (pool of Grand Rapids Dam).
	102.5	102.4	500	1,000	6.2	
Hanging Rock	99.6	99.0	2,900	840	6.9	
	98.2	98.1	800	700	9.9	
Above Grand Rapids Dam	97.8	97.2	3,300	860	8.7	
Below Grand Rapids Dam	97.0	96.7	1,500	560	5.0	
White River	95.6	95.0	2,900	740	2.1	
Patoka Island	93.0	92.3	3,500	1,100	10.9	
Coffee Island	89.7	88.1	8,300	980	4.6	
McClearys Bluff	79.9	78.6	6,800	850	3.6	
Grayville	65.2	64.5	3,500	680	6.4	Rock ledge on right bank; average width, 120 feet.
Illinois Central R. R. bridge	63.0	62.6	2,000	840	5.1	Rock ledge on right bank; average width, 100 feet.
Mink Island (Warwicks Ripple)	41.0	37.8	16,200	1,040	7.1	
Grand Chain	31.7	29.3	12,500	920	6.5	
Little Chain	25.6	23.8	9.000	740	4.3	
Total	.....	.....	132,900	.....	.....	
New Harmony Cut-off	43.3	41.9	7,500	600	7.1	

Bars.—In the stretch of the Wabash under cosideration there are 80 bars or obstructions over which the best depth at mean low water is less than 4 feet. These obstructions vary in length from 300 feet to 1½ miles. To these must be added the "Old River" below New Harmony, 9 of the 10 miles of which come under this head.

These bars are of sand or gravel, except at the following localities, which are of rock: Pork Island (119), St. Francisville (114), Poker Creek (110), foot of Grand Rapids Lock (97), White River bar (95), Coffee Island (89), McCleary Bluff (80), Warwicks Ripple (39), Grand Chain (31), Little Chain (25), mile below Little Chain (24), and the New Harmony cut-off (42).

The following table shows the location and extent of all the bars over which there is less than 4 feet of water, and their chief characteristics:

TABLE No. 21.—*Wabash River—Bars.*

[At mean low water stage.]

Distance above mouth.	Length of bar.	Character of bottom.	Width of river.	Mean depth.	Least depth.	Section of least depth.	Slope.	Locality.
Miles.	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
213	6,600	G. M....	540	3	2.3	2.2	1.1	Lower Terre Haute.
206.9	1,200	G.....	360	3.1	2.8	2.1	5.8	Musgrave Ripple.
199.7	900	G.....	600	2.4	2.2	2	5.3	Raymonds Ripple.
197.8	1,240	G.....	350	3.3	3.3	3.1	5.3	Strams Ripple.
195.6	2,450	G.....	570	3	2.2	2.1	3.8	Big Creek.
194	2,900	S. G....	480	3	2.1	2.1	1.9	Head Darwin Cut-off.
190.2	540	S.....	540	3.5	3.4	3.3	3.5	Darwin.
188.4	1,800	S. G....	440	3.3	3.6	3	1.8	Bowers Ferry.
183.5	7,900	S.....	580	3.5	3	2.7	.8	Chenoweths Reach.
178	300	G.....	200	3.7	3.7	3.4	4	Devils Elbow.
176	700	S. G....	470	3.2	2.7	2.7	2.1	
175.1	1,440	G.....	480	3.7	2.8	2.3	3.2	Greers Ripple.
171.7	900	G.....	500	3	3.1	2.3	1.1	Hutsonville.
170.4	2,600	G.....	600	2.9	2.3	2	1.1	Island.
169.6	700	G.....	470	2.9	2.3	2.2	.7	Turmans Creek.
168.7	830	G.....	470	3.2	2.6	2.5	1.1	
167	1,250	G.....	530	3.3	3.7	3.2	1.9	
163.1	700	S. G....	500	2.7	2.4	1	1.2	Eagle Island.
162.2	2,060	S. G....	470	3.3	3.3	2.3	.6	Do.
161.4	900	S. G....	540	3.4	3.8	3.3	.3	
159.4	400	S.....	430	3.3	3.3	3	.5	
158.5	1,000	G.....	500	3.4	3	3	.1	Lamotte Creek.
157	1,830	S. G....	500	3.2	2.7	2.6	.1	Below Palestine.
155.6	600	S.....	620	3.5	2.9	2.6	.3	
154.6	1,100	S. G....	500	3.6	3.7	3.4	.5	
151.2	400	S. G....	480	3.6	3.9	2.4	.5	
150.5	300	G.....	310	3.5	3.3	2.8	.8	
148.7	350	G.....	290	3.5	3.5	3.2	.8	Blacks Ripple.
143.7	1,700	G. R....	420	3	1.9	1.8	.3	Swan Island.
142.3	2,500	S. G....	500	3.4	3.2	2.9	.9	Busseron Creek.
141.5	2,500	S. G....	510	3	2.2	2.2	1.2	Do.
140.7	1,600	S. G....	560	2.6	1.2	.9	.5	Russellville.
140.1	900	G.....	410	3.3	3	2.7	.4	Do.
139.1	1,500	S. G....	480	3	2.1	1.3	.4	
138	4,700	S. G....	470	3	1.7	1.4	.4	
137	2,300	S. G....	510	2.7	.9	.6	.4	
136.2	2,400	G.....	290	2.7	1.2	1	.5	
135.7	1,600	G.....	480	3	2.3	2.3	.5	
135.3	1,400	G.....	340	2.7	2.3	1.8	.5	
134	1,000	S. G....	290	3.3	2.2	2	.8	Seven Mile Island.
133	2,100	G.....	510	3.1	2.7	2.3	.5	
130.8	2,800	G. S. R.	590	3.5	2.7	2.1	.5	
129.5	2,100	G.....	580	2.6	1.9	1.8	.5	Kelsos Creek.
128.2	800	G.....	600	3.2	2.9	2.9	.8	B. & O. S. W. R. R. bridge.
127	3,500	S. G....	640	2.9	2.3	2.2	.8	
125	5,600	S. G....	620	3.4	3	2.9	.6	
123.4	3,100	S. G....	600	2.9	2.5	2.3	.9	
119.2	1,800	S. G. R.	550	2.3	1	1	.8	Nine Mile or Pork Island.
116.8	400	G.....	510	3.4	3.3	2.8	.5	
115.8	700	S. G....	540	3.7	3.7	3.4	.8	
114.4	4,300	S. G. R..	660	3.2	2.9	2.9	.7	St. Francisville.
111.7	1,300	S. G....	680	3.3	3.4	3.3	.3	
110.2	7,100	G. R....	600	3	2.3	2.3	.6	Poker Creek.
105.7	4,900	M. R....	830	3.2	2.5	2.4	.1	Above Little Rock.
103.4	800	M. R....	1,120	3.8	3.8	3.7	.....	Pool of G. R. Dam.
97	500	S. R....	610	2.3	1	1.3	.3	Foot Grand Rapids Lock.
95.3	2,300	R.....	880	2	1	.5	2	White River (dike).
93.5	600	G.....	730	2.7	2.7	2.5	.....	Patoka Island.
93	2,100	S. G....	760	3.2	2.6	2.6	.6	Do.
92	1,100	S. G....	1,030	3.7	3.6	3.6	.4	
91	2,600	S. G....	900	2.8	2.4	2	.9	Duck Island.
89.4	4,400	S. G. R..	1,010	2.2	2	.9	1.1	Coffee Island.
83.3	400	G.....	950	3.7	3.5	3.5	.5	Jimtown.
82.4	1,700	S. G....	1,040	3	2.7	2.7	.4	
79.6	1,800	S. R....	730	3.4	3.1	3	1	McClearys Bluff.
66.4	300	S.....	870	3.9	3.8	3.8	.6	Kingdom Island.
64.4	1,700	S.....	860	3.3	3.2	2.9	.5	Grayville.
60.5	4,000	S. G....	980	3.5	2.7	2.7	.5	Little Fox River.
47.8	34,500	S. G....	200	1.2	.2	.2	.8	Old River.
42.8	12,800	S. G....	240	1.5	.3	.2	.3	Do.
40.4	700	S.....	900	3.9	4.1	3.8	.2	Mink Island.

TABLE No. 21.—*Wabash River—Bars*—Continued.

[At mean low water stage.]

Distance above mouth.	Length of bar.	Character of bottom.	Width of river.	Mean depth.	Least depth.	Section of least depth.	Slope.	Locality.
Miles.	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
36.4	3,700	S. G.....	1,230	3.7	3.5	3.3	.3	Twin Sister Island No. 1.
31.3	2,500	R.....	660	1	1.3	1.3	4.8	Grand Chain.
30.7	500	S.....	1,020	3.2	3.2	2.4	.3	L. & N. R. R. bridge.
25.3	1,900	R.....	750	1.8	1.8	1.8	2.7	Little Chain.
24.2	3,100	R.....	870	3.7	2.9	2.9	.6	L. C. Cut-off, foot.
18.5	1,600	S.....	880	2.9	2.8	2.7	1.1	
12.6	1,800	S. G.....	1,030	3.6	4.4	3.4	1	Park Landing.
7.1	2,100	S. M....	1,060	2.5	2.4	2	1	Mackeys Island.
3.2	1,400	G.....	780	3	2.6	2.6	2	
1.7	2,200	G.....	760	3	2.3	2.3	1.6	
.8	2,400	G.....	640	3.6	2.6	2.5	1.8	
42	1,000	R.....	420	.....	.2	.....	12.7	New Harmony Cut-off.

EXPLANATORY NOTES.

Column 1. Distance of the middle of bar above mouth of river.
Column 2. Length of the bar whose depth is less than 4 feet.
Column 3. Character of bottom: S=Sand, G=Gravel, M=Mud, R=Rock.
Column 4. Average width of river at bar.
Column 5. Average best depth of water over the bar for a width of 100 feet.
Column 6. Least or controlling depth of a single line of soundings along the channel.
Column 7. Mean depth of the least or controlling cross-section of 100-foot width in channel.
Column 8. Slope over the bar in feet per mile.
Column 9. Nearest town, creek, or other well-known place.

FORMER IMPROVEMENT WORKS.

The Wabash has been under improvement by the United States since 1872, but no new work has been done since 1898. The appropriations for this work after 1880 had been separated for "Above Vincennes" and "Below Vincennes," and the total amounts expended prior to the survey of 1911, not including maintenance, examinations, and surveys, was—

Expended below Vincennes	$714,957.20
Expended above Vincennes	95,254.87
Total	810,212.07

Except the lock and dam at Grand Rapids, nearly all the work done in the Wabash has either been destroyed or rendered useless by deterioration and the river action. The following is a brief description of these improvement works:

Eight-Mile Island (206).—The river at this place, 8 miles below Terre Haute, is divided by the island into two channels. In 1882 the Government built a dam, 270 feet in length and 2 feet above low water, across the smaller channel. It was built of cribs, brush and stone, and the shores on each side were protected for a distance 40 feet above and 90 feet below. This dam is still in existence and there is a depth of over 4 feet at low water in the main channel.

Horseshoe Island (145.8).—At this locality a cut-off had been made by the river forming Horseshoe Island. Owing to the division of the discharge here this was the most difficult point for boats to pass above Vincennes.

A dam was built across this cut-off and the banks protected in 1884. The dam was 220 feet long, 60 feet wide, and projected 2 feet above low water. The shore protection extended along both ends, a total of 465 linear feet. As in the case of the dams in the New Harmony and Little Chain cut-offs, the river cut its way around the island end of the dam in 1885–86.

Since then no work was done here, except snagging and the river now takes the cut-off route, the old channel having practically filled up.

Grand Rapids Lock and Dam (97.1).—This place had originally been a complete bar to navigation in the Wabash except at high stages, being a rock rapids with a fall of 10 feet in 700. A private corporation, known as the Wabash Navigation Co., with a charter from the States of Illinois and Indiana, built a crib rock dam and wooden lock here in 1848. This charter was purchased for $7,000 by the Government in 1874, but no new work was contemplated until its expiration.

In 1887, the old lock and dam having become useless, the Government began the construction of the present dam and lock, which was completed in 1894. It is more fully described in the preceding part of this report. Since its construction some money has been spent in repairs and maintenance, and in 1908 the old wooden guide and guard walls were replaced by concrete ones. The structure is at present in fairly good condition.

Coffee Island (89.5).—At this place there is an island about one-half mile long, with a chute about 125 feet wide on the Indiana side, and impassable rock bottom extending across the river to the Illinois bank on the other side. In 1872 to 1874 the Government excavated the bottom of this rock chute and used the rock to build a dike about 2,000 feet long, extending from the upper end of the island diagonally across the river, with a view of deflecting the low water flow through the chute. This dike is still effective, although it has been partly washed away and a channel of about 30 inches in depth is now available at mean low water.

Grayville (65).—At this place there is a deep bend in the river about three miles long surrounding a narrow point, the river threatening to cut through the neck of the point, leaving the town of Grayville inland. A ravine across this neck increased the danger. A levee had been built up the middle of the point to prevent the flow of water across, but it had long since broken away.

In 1878 bank protection of piling, brush, and stone, 3,500 feet in length, was constructed on the upper side of the neck and for 900 feet on the lower side. A small brush dam was built across the ravine and the levee was rebuilt of "brush, posts, and earth." A wing dam, 400 feet long, of piles, brush, and stone was built out from the upper end of the lower revetment to improve the channel at this point, known as the Kingdom Bar (64).

A similar dam was begun a short distance above on the opposite shore, but work was abandoned because the rocky bottom prevented the driving of the piles to a suitable depth. In 1886 the banks were again caving at this point, and a channel 200 feet wide and 13 feet deep had been cut across the neck, which was now only 650 feet wide. The following year the levee was reconstructed and lengthened and in 1888 a stone dike 2 feet high, 8 feet wide, and 1,000 feet long was constructed as an extension of the eastern end of the levee. In 1890–91 ten spur dikes were built to further protect the bank at the upper side of the threatened cut-off. The dikes were composed of cribs 12 feet wide, and sloped from the top of the bank to the river bottom. They were an average length of 90 feet and spaced from 300 to 700 feet apart. The levee was also extended in 1891, as an earth embankment, 1,750 feet to the east, making its total length 6,080 feet.

No work was done here since that date. The levee at present is in fairly good condition, and the banks are apparently stable, and the narrowest point of the neck is 760 feet across.

New Harmony (51.5).—Above the entrance to the cut-off the shore had been rapidly cutting away, changing the channel and widening the entrance to the cut-off. To stop this erosion, a shore protection, 714 feet long, of a single row of piles with brush and stone was constructed here, and a wing dam built, "64 feet long, 15 feet wide, and 12 feet deep." This work is now covered by the bank which has been made over it, following the failure of the dam across the cut-off below.

New Harmony Cut-off (51).—The most important obstruction in the lower Wabash has always been the channel around Ribeyres Island, just below New Harmony (52). The "Old River," as it is called around the island, is 10 miles in length, and for 9 miles there is practically no water for navigation at low stages. The bottom is sand and gravel. This island was formerly a point of land which was cut off by natural agencies more than a century ago. The cut-off is 2¼ miles in length, 1,000 feet of which, near the lower end, is a rapids which is practically unnavigable below a 12-foot stage, having a rough rock bottom and the water at one point falling precipitately over a 4-foot rock declivity at low stages. A milldam was once located here, but no remains thereof are now visible.

The greater part of the discharge goes down the cut-off route at all stages, and in order to deflect the water back into the old channel the Government built a dam across the head of the cut-off. This dam, as finally completed, was 575 feet long and about 15 feet above low water, constructed of cribs filled with rock and an embankment of earth placed against the upper side of the cribwork. Shore protection at both ends formed part of the work. The work was begun by contract in 1875, but owing to the inefficiency of the contractors

the contract was annulled in 1877 and the work completed by hired labor in 1878. It was repaired and lengthened the following year and required constant repairing thereafter. No work was done on the dam in 1885 and in 1886 the river cut a new channel around the island end of the dam and now flows there as before, while the dam acting as a dike formed a point of land connected with the main shore.

It is my opinion that a lower dam would have answered the requirements of navigation and would have been easier of construction and maintenance.

Turkey Island (48.8).—At this place, which is in the "Old River," below New Harmony, Turkey Island divided the stream into two channels, both being nearly impassable at low stages. The Government built a dam across the head of the narrower channel, known as the "chute," in 1879. This dam was 350 feet in length, 62 feet wide, and 13 feet high, and was built of piling, brush, and stone. It is said to have increased the depth of the main channel about 2 feet. The dam was repaired in 1882.

At present no water goes through the chute until a stage of about 5 feet is reached.

Hodges Landing (45.3).—This locality is also in the "Old River." The channel was shallow and the bank caving. In 1880, 300 feet of this caving bank was protected by a single row of piles and brush and stone placed between the piles and the bank. None of the works constructed in the "Old River" are now of any value, as that entire stretch is unnavigable at low stages.

McIntyres Bar (44.2).—This place was in the "Old River." The river was wide and the channel shallow and uncertain, while the banks in the bend were caving. In 1880, 500 feet of the bank was protected with piling, brush, and stone, and a small wing dam is reported to have scoured out and greatly improved the channel.

Winklers Bar (43.5).—This bar of sand and gravel was in the "Old River," about 2 miles above the foot. The bar divided the flow and was a serious obstacle to navigation. In 1880–81 a wing dam, 1,800 feet long, was built of piles, brush, and stone from the head of the bar to the main bank of Ribeyres Island. It is said to have increased the depth in the channel about 3 feet.

Warwicks Ripple (39).—The river at this place was very shallow, with a rock bottom, and the project proposed was to cut a channel 200 feet wide and 2 feet deep and 7,000 feet long through this rock. The contract for this work was let in 1875, but owing to unfavorable conditions of the river, work was delayed, and in 1877 the contract had expired without any excavation being made. Work was resumed by the Government in 1879. The remains of the cofferdam of 1875 were removed and some rock excavated in that and the following year. The work was never completed, but some improvement resulted, and there is at present about a 3-foot depth over the reef in the channel at mean low water.

Grand Chain (31).—This obstruction, 2 miles below Maunie, Ill., was a rock rapids over which there was very little depth at low water and a large fall. In 1873 and 1874 the Government cut a channel 2,000 feet long and 100 feet wide through the rock and built a dike on each side thereof several feet in height, the eastern one connecting with the main shore. The original work was done by contract, but the east dike was extended and its height increased by hired labor in 1879 and 1880.

As a result of this work there was a channel depth at low water of something less than 2 feet through the chute thus formed, and the velocity was about 7 feet per second. Navigation was possible only at a stage 1 or 2 feet above low water, the descent was dangerous, and only powerful boats could stem the current in going upstream.

The present condition has changed but little. The width between dikes is about 85 feet, and towheads have been formed by both dikes. The upper part of the eastern dike has been almost entirely destroyed and there are several other breaks in the dikes.

Little Chain (25).—A rock reef extending across the river caused the obstruction at this place. A chute behind the island on the Indiana side, known as Little Chain Cut-off, was cleared of brush, snags and logs by the Government in 1876–77, with a view of assisting the river to scour out and widen this channel. Some dredging was also done near the head of the chute. As the work seemed to be ineffective, a dam of piling, brush, and stone was built to increase the flow over the reef across the head of the cut-off in 1880 and protected at the shore ends. In 1886 the river cut a channel around the island end of this dam, as in the case of the New Harmony Cut-off, thus rendering the

work useless. In 1881–1883 a channel, 1,860 feet long and 35 feet wide, was cut through the reef by the Government, and a crib dike, 4 feet high, filled with the stone from the excavation was built along its Indiana side. In 1911 none of this work was apparent, and the best channel over the reef at mean low water had less than a 2-foot depth.

Dredging.—Very little dredging has been undertaken in the Wabash River, except such as would come under the head of rock excavation. In 1872–73 a channel 100 feet wide was dredged under contract from the mouth to a point 31 miles up. Work was in progress during 105 days. There is no other definite information regarding the work.

Two dredges were taken from works on the Ohio River in 1878 to Grayville, 65 miles above the mouth. It was intended to dredge all the bars from there to the mouth, and the work was begun on the Kingdom Bar about a mile below Grayville. The report of 1878 says that the bar was "composed of an extremely light sand, so fine that it could hardly be held in the scows," and further, "an examination of the other bars where dredging was proposed showed that all were composed of sand, and as but little good would have resulted from dredging where the bottom is so light and easily moved, this part of the work was abandoned."

In 1883 a boom dredge was built for use on the Wabash and White Rivers, but this was used chiefly in conjunction with the rock excavation at the localities cited above.

Snagging.—Snagging operations on the Wabash were in progress almost annually between the years 1872 and 1898. The work consisted of raising and cutting up snags and dumping them in places that it was intended to close or fill up. Overhanging trees were also removed by the same outfits. The snagging in 1872–73 was done by contract, subsequent work by hired labor. In 1878 the Ohio River dredges before mentioned did considerable work removing snags, and in the following year two snag boats were built for the Wabash at a cost of $5.255 each. One of these, however, was used entirely in the White River, while the other was used below Vincennes. In 1881 another snagging outfit was built for use above Vincennes. It consisted of a towboat and two barges, one of the latter being rigged to handle the snags and the other as a scow for carrying them away. Both outfits were quite successful in their operations and many snags, dangerous to navigation, were removed annually. The work was suspended in 1899 owing to lack of funds. The present condition of the river as to snags has been described in a previous part of this report.

GEO. H. WOLBRECHT, *Assistant Engineer.*

APPENDIX B.

INSTRUCTIONS FOR CHIEF OF PARTY.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., April —, 1911.

Wabash River survey:

1. This survey will extend from the mouth of the river to include the water front of Terre Haute, Ind., a distance of approximately 215 miles. Its object will be the obtaining of sufficient data for the preparation of a project for the improvement of the stream to secure a navigable depth of 6 feet at all periods of the year over all obstructions by the method of locks and dams, by regularization, or by a combination of the two methods with that of dredging.

2. There is available for the work $25,000, which sum should be made to cover not only the work of the survey in the field, but also the work that must be done in the office in the preparation of maps, plans, and estimates. It is expected that the fieldwork will extend over two seasons, and that the final report will be made in the winter of 1912–13.

3. As much use as practicable will be made of the existing surveys, the sheets of which will be furnished to the field parties as they are needed. All permanent points of previous surveys, which can be found without difficulty, will be touched on by the proposed survey.

4. The survey will be prosecuted so as to obtain the following results:

(*a*) A representation of the bed and banks of the stream to the elevation of extreme high water.

(*b*) A channel profile showing accurately the low-water slope.

(*c*) Discharge observations at Terre Haute, Vincennes, Mount Carmel (below the mouth of White River, and also the discharge of the latter stream near its mouth), New Harmony, and at a point just below the mouth of the Little

Wabash, at stage of the lowest available. and at or about each 5-foot increase of stage between low water and bank full.

(*d*) Borings in the stream bed extending over every existing bar on which the low-water depth in less than 6 feet; and also at probable lock sites, i. e., as determined in the report on the survey of 1902–3, and at points between Vincennes and Terre Haute, where an assumed 9-foot lift would place locks for 6-foot navigation; especially will these be made at the following localities where lock sites will certainly be located: Foot of Little Chain, Warwicks Ripple, Coffee Island, Pork or Nine Mile Island.

(*e*) An accurate determination of the water slope over all obstructions of major importance at the low-water stage and at or about each even-foot stage between low water and bank full. An obstruction of major importance is one in which the depth at low water is less than 6 feet, and the slope at low stages exceeds 2 feet per mile.

(*f*) Special surveys at each proposed lock site, and at all major obstructions to show the details of stream bed and immediate banks in more detail than will be shown on the general sheets.

(*g*) There will be particularly noted all caving banks and the extent of the bank in each case where cutting is in progress; and on the new survey maps an approximate line will be drawn to show the location of the top of the bank at the time of the 1902–3 survey, and of the 1879 survey.

(*h*) The location of the proposed New Harmony-Patoka Levee will be shown where the same falls on the limits of the general sheets.

5. *Control.*—For control a base line will be run on the top of the bank. It will be measured by steel tape, and the tape measurements will be checked by stadia readings. This base line will be traversed by transit and the angles will be repeated three times, the mean of three readings being taken for the azimuth and the orientation of the instrument on the forward station. The magnetic needle will always be read for check on the azimuth. Stadia readings for check on the base line will be less than 600 feet, and when the stadia measurements of base differ from the tape measurements of the same by as much as 1 in 300 the line will be rechecked, and, if necessary, retaped. Astronomical observations for corrected azimuths will be made in order that one such correction may be made in every 10 miles of base line run. Permanent points will be established on this base line at intervals of 1 mile.

6. *Precise levels.*—A duplicate line of precise levels will be run for the entire length of the survey. This is one of the most important features of the survey, and the work will be prosecuted in accordance with the published instructions of the Mississippi River Commission in so far as they are applicable. Permanent bench marks will be established at intervals not to exceed 5 miles, and one permanent bench mark will be established at or near each probable lock site or major obstruction. Especial care will be exercised in placing these marks with a view to permanence and recovery. Immediate proximity to the river bank is not essential.

7. *Topography.*—The topography of the space between low water and the top of the immediate river banks will be taken with a view of platting contours at 5-foot vertical intervals by the method of transit and stadia; running cross sections directly up the banks at intervals depending on variations of slope and curvature, due care being exercised that sections are not taken unnecessarily close together. Where conditions are uniform it is thought that for the general sheets that these cross sections may be about 500 feet apart, and for special detailed sheets 200 feet apart.

The topography of the bottoms will be obtained by running sections normal to the general direction of the immediate river valley and about one-half mile apart, taking points on these sections at ridge and dip points, and at points of decided change of slope. all intermediate country will be sketched, using hand level where necessary.

All topography of whatever nature will be controlled by the base line.

8. Hydrography will be determined by soundings taken from a skiff and located by intersections from a transit point, said transit point being located from the base line. The low-water elevation will appear on the map at every variation of 0.1 foot, and the soundings will appear as elevations of the bottom rather than as depths below low water. On the general survey the sounding ranges will be 600 feet apart and normal to the general direction of the channel line, except that on all bars where the low-water depth is less than 6 feet the sounding ranges shall be 200 feet apart. The soundings on a range will not be less than 40 nor greater than 100 feet apart; on obstruc-

tions they will approach the former interval and in deep and uniform reaches the lateral interval. For the reduction of soundings to elevations a water-surface peg on each range will be driven and its elevation determined by Y level.

The low-water surface will be determined by the combined evidence of the water-surface elevations and the gauge readings of the survey and of previous years at the lock at Mount Carmel. The final result must be obtained after platting the lowest available uniform stage given by the survey gauges and water-surface elevations by then platting a parallel stage through the lowest known stage of past record.

9. *Discharge observations* will be made by current meter where practicable; otherwise by subsurface floats at mid depth. The current meter will be used to obtain mid-depth velocities at points 100 feet apart on the selected cross section of the stream, and these mid-depth velocities shall be reduced to mean velocities by proper reduction. There will be one current meter party organized when it is thought that low water for the season has arrived, and this party will make the necessary observations at the successive sites selected as rapidly as possible. But should it be evident that this party, suitably equipped, can not reach all points selected within a reasonable time, special parties shall be sent out to gauge with floats. In selecting the actual point for gauging care must be exercised to select so that the stream shall be nearly straight and the cross section nearly symmetrical for one-fourth mile each way from the cross section under consideration. The selection of the sites for gauging, the accurate determination of cross sections, and the measurement and marking of the necesary base lines will be made in advance of the time of gauging, but sufficient soundings must be made at the time of gauging to insure that no decided change has taken place in the cross section since the original measurements.

10. *Borings.*—The borings will not be core borings but must determine without doubt the existence and depth of bedrock should same occur at depths affecting any probable operations of improvement. The holes put down must be approximately located from known points on the survey. The precise location of a boring hole is not essential, but should it be practicable in conjunction with other work to locate each hole instrumentally it will be done; otherwise the holes will be on certain specified sounding lines, clearly marked for identification by the boring party, which will roughly measure or estimate the distance of the hole from the water line. The holes will be put down as follows: (*a*) At the locality of every lock site and extending one-half mile each way from the probable location as determined by the chief of party; the cross sections for borings will be 600 feet apart and three holes will be put down on each cross section to bed rock or to a depth of 25 feet below low water if bedrock does not exist in that depth; one of the holes on each cross section shall be near midstream and the other two shall be as near each bank as the drill scow will float. Probable lock sites are as indicated in paragraph 3. (*b*) At every bar on which the low-water depth is less than 6 feet two holes will be put down on a cross section, cross sections being 600 feet apart, and the two holes of a section being on opposite sides of the channel line and about 200 feet apart. These holes will be driven to a depth of 8 feet below low water in search of solid rock. The general method for all borings shall be as follows: Drive down a piece of casing to the full depth or till solid material stops the driving; in the latter event put the jet into the casing and clean out to the bottom; drill into the hard material a foot, judging from the action of the drill and the cuttings as to the nature of the hard material; if it is rock the hole is then complete; if it is not rock, drive the casing down to limiting depth. At each locality where borings are made at least one hole will be jetted down all the way, a careful record of the material made, and a sample of the jetted material preserved for future reference.

11. *Water slope over obstructions.*—At all major obstructions the slope from the head to foot of the obstruction will be determined at various stages from the lowest to bank full by two or more gauges very carefully set and read daily at fixed hours; these gauges will form a part of the regular set to be established, but especial care will be observed both in the setting and in the selection of observers. The survey parties when in the vicinity of these gauges will read them to hundredths and will at the same time check their difference in elevation.

12. *Gauges* will in general be set as soon after the receipt of these instructions as possible. An examination of the existing profile will be made and the sites

for gauges will as a rule be set at points of sudden change of slope. Influencing this selection of sites will be the securing of proper observers in the neighborhood and the rule that no two gauges shall be farther apart than 25 miles. The gauges shall be of seasoned plank 2 inches thick—subdivision feet and tenths, white background and black subdivisions, black foot numbers 4 inches high—and there shall be printed on the gauge, "Gauge—U. S. Engineer Department." No special effort will be made to set the zeros of the gauges at extreme low water, only rough approximations being desired in this respect, but the precise level party will determine the elevations of the zeros of all gauges. In case any gauge has to be set in two or more separate parts a Y level will be used to secure accurate continuity of the graduations. Great care must be exercised in the substantial setting of the gauges and in selecting secure places not likely to be visited by heavy drift and piling ice. In case no suitable support exists set a 6 by 6 inch post 6 feet in the ground, fill around it with tamped gravel or good binding earth, and have the part above ground 10 feet long to receive the gauge, which should be held by 6 by ½ inch lag screws. The ordinary gauges need not read higher stages than bank full, and the setting of the upper 12 feet of the gauges may be deferred till the survey is in progress.

13. *Maps.*—The general map will be on a scale of 200 feet to 1 inch, and the contour interval shall be 10 feet. So much of the bottom-land topography as can be shown on the sheets of the general map will be shown. The maps of all special localities shall be on a scale of 100 feet to 1 inch, and the contour intervals shall be 5 feet. Special maps shall be made of all localities selected as lock sites and at those classed as major obstructions. An index map on a scale of 6 inches to 1 mile will be prepared, and on this map will appear all features of the survey that the scale will permit; all bottom-land topography will appear and the contours will be shown at 15-foot intervals except on flats where the interval will be reduced so as to show the surface of the ground. All boring records will appear on the sheets on which the holes are located.

14. As much of the platting will be done in the field as is practicable and the method of coordinates will be used for base line and closed circuits. All sheets will be 26¾ by 40 inches cutting line, and there will be one-half inch border. All work will be in black and no construction lines not necessary to a full understanding of the map will be shown. Each sheet will show the scale and the orientation and a brief of the title. The provisions of G. O. No. 9, O. C. E., will be observed as far as practicable in the preparation of maps.

The following data will appear on the general and special maps in the form of notes, figures, or topographical signs; elevations of river bed, low-water permanent bench marks, low water for every variation of 0.1 foot, flood points with date of flood, contours; the low-water lines, heavy, full lines; swamps, woods, willows, cultivated land, sand bars, nature of bottom of river; houses, with character, as frame, brick, log, barn, shed, dwelling, corncrib; roads—county, improved, unimproved; levees; pipe lines; bridges—elevations of lowest points over channel and length of spans; ferries; caving banks; rock bluffs; notes as to coarse gravel and coarse sand suitable for concrete; railroads, with correct names; coal mines; quarries; towns—maps to be obtained if possible; landings—names; tributary streams, with note as to approximate drainage area; property owners and property subdivision lines, on special sites only; and, in general, any other features not mentioned which may be of use on the map for the purpose that the survey is intended to serve. The finished maps shall be in full, strong lines with figures and notes firm and black and of size to give clear results from photo reduction to one-fifth. The requirements as to what must appear on the maps must be made clear to all topographers and sketchers, and all topographers must prepare field sketches on the scale of the general map for the use of the drafting force. These sketches must be in full detail and made with the country in sight.

15. *Field administration.*—The chief of party will be in the field at all times with one or the other units of the survey. Such travel as may be necessary in the proper administration of the work is authorized, but he shall keep his office fully informed as to his location and movements in order that he may be reached at any time by mail and telegraph or telephone. He will make to this office on the 10th, 20th, and last day of each month a report showing clearly the progress of each element of the work, and will make a subdivision of the cost of the work according to its various classifications. He will certify the correctness of all bills for materials received and for time rolls submitted. He will be responsible for all plant and equipment and other pubic property pertaining to the survey. The property must be frequently checked, and any

loss must be cleared promptly by proper affidavits or the responsible parties made to replace.

The purchase of supplies shall, as far as practicable, be made through timely requisition on this office; and for supplies necessary at once great care will be taken to secure them at reasonable prices. The cost of subsistence will be limited to 50 cents per man per day.

The greatest care will be exercised to secure the health of the men in the field. Provision will be made for pure drinking water, and personal supervision on the part of the person immediately in charge of men will be required in this particular. In case river water is used for drinking it must be boiled, and the receptacles for the same must be scalded daily. Each man's attention must be called to the necessity of drinking only the water provided for use, and any willful disregard of this advice will be cause for discharge of the offending party. The quarter boats shall be kept in a thoroughly clean and sanitary condition. Particular care will be taken to keep them clear of mosquitoes and flies; the latter will not be tolerated in kitchen or dining room.

The introduction of intoxicating liquor on any boat or in any portion of the party by a member thereof will not be allowed; any member of the party who violates this rule, or who appears on any boat of the party under the influence of liquor, will be discharged summarily, action being reported to this office.

Gambling or games of chance for money will not be permitted on any boat of the party or in the vicinity thereof.

Insubordination, filthy habits, or any trait of any member of the party tending to make him generally obnoxious, will be good and sufficient cause for discharge.

A set of rules including the above requirements and penalty will be made and posted in a conspicuous place in each quarter boat before the boat is placed in commission.

Before going into the field the chief of party will prepare for each instrument man or other person in charge of a subparty minute written instructions covering the duties to be performed by that subparty. This will include the drafting force. These instructions shall be approved by the engineer officer in charge.

16. *Organization.*—The organization is to be drawn up with the general idea of carrying out the precise levels, the base-line control, and topography of the immediate banks, the hydrography, the borings north of New Harmony, and the gauge readings simultaneously, and beginning as soon as the parties may be organized and put into the field; the discharge observations to be begun at the lowest available stage; the topography of the bottoms after the first frost; and the lower-river borings after the completion of the lock-location survey is completed on the Ohio. It is intended to start from the mouth of the Wabash and work upstream with a proper party from the Ohio River survey as soon as the latter work is completed, which is estimated as not later than August 1, 1911.

The exact organization is left to the discretion of the chief of party, as is the detailed list of instruments and supplies; but when all of these matters have been decided upon they will be submitted to the engineer officer in charge for approval, and when approved will form part of these instructions.

17. *Existing data.*—It is to be noted that the Geological Survey has finished its topography from the mouth of the river to Mount Carmel, Ill.; and if this work is available the topography of the bottom lands so covered will be omitted in the survey, and the base line for control may also be omitted if the control of the Geological Survey can be utilized. A list of all Geological Survey bench marks along the route of the survey will be prepared for the use of the precise-level party, and they will be checked upon when not too far distant.

LYTLE BROWN,
Captain, Corps of Engineers.

APPENDIX C.

DESCRIPTIONS OF "PRECISE LEVEL" BENCH MARKS, ESTABLISHED OR CONNECTED WITH WABASH RIVER SURVEY, 1911. TERRE HAUTE, IND., TO SHAWNEETOWN, ILL.

EXPLANATORY.

The standard P. B. M. established by this survey was a concrete slab surmounted by an iron pipe. The slab is 16 by 16 by 4 inches and set about 3 feet

underground. Elevations were taken on copper bolt imbedded in concrete at center of slab. The iron pipe surmounting slab is 4 inches in diameter and 4 feet long with cap bolted to top. Elevations were taken on center of cap. (Center of cap is directly above bolt in slab.)

The bench-mark pipes established during previous surveys, and connected with (1911) are 3-inch iron pipes, 5 feet long, and set about 4.5 feet in the ground. Elevations on these were taken on knob on cap of pipe.

Abbreviations R. B. and L. B. refer to right and left bank of the Wabash River.

P. B. M. "Post Office."—(U. S. G. S. B. M.), aluminum tablet stamped "513," in Terre Haute, Ind., at NE. corner of post-office building. Elevation, 513.201 feet.

P. B. M. "Union."—(U. S. G. S. B. M.), aluminum tablet stamped "495," in Terre Haute, Ind., in front face, at SW. corner of union station. Elevation, 495,286 feet.

P. B. M. "Traverse."—(U. S. G. S. B. M.), iron post stamped "Prim. Trav. Sta. No. 22, 1906," at E. side of Chicago & Eastern Illinois Railroad, in Terre Haute, Ind., N. of Fort Harrison Pike crossing, 26.6 feet E. of E. rail of track. Blazed elm tree; S. 19° 15′ E. 43 feet. Elevation, 496.955 feet.

P. B. M. "Vandalia No. 1."—(U. S. E. B. M. survey, 1903; also U. S. G. S. B. M.), cross in center of chiseled square at Terre Haute, Ind., about 1 mile W. of union station, on top of bridge seat, on S. abutment on E. side of Vandalia Railroad bridge across Wabash River. Elevation, 482.717 feet.

P. B. M. "Vandalia No. 2."—Square cut within a square at Terre Haute, Ind., on SW. corner of bridge seat of W. pier of Vandalia Railroad bridge, about 1,200 feet across bridge from P. B. M. "Vandalia No. 1"; letters U. S. B. M. cut near square. Elevation, 482.663 feet.

P. B. M. No. 1.—Concrete slab and iron pipe in Taylorville on R. B. opposite Terre Haute, Ind., on property of Louis Heyden; about 400 feet N. of W. end of Wabash Avenue highway bridge and 16 feet W. of top of made high bank; pipe stands 15 inches above ground in NE. corner of said property. Lat. 39° 28′+258.8; long. 87° 25′+1,451.5. Elevation: Bolt in slab, 471.704; cap on pipe, 475.758.

P. B. M. "Wabash."—Cross in center of 2-inch chiseled square at Terre Haute, Ind., in E. end of concrete approach to abutment at N. side of highway bridge over Wabash River at Wabash Avenue; 6 feet from end post and 4 inches outside of guard wall. Letters B. M. chiseled in concrete S. of square. Elevation, 487.348.

P. B. M. "Brewery."—Square cut on N. end of lower step of entrance to office building of People's Brewing Co., at Terre Haute, Ind., corner First and Wilson Streets, marked "U. S. B. M." Elevation, 498.315.

P. B. M. No. 2.—Concrete slab and iron pipe on L. B., in lower part of Terre Haute, Ind., in front yard of cottage at 613 Prairieton Avenue; cottage is on W. side of avenue and is first house S. of Commercial Distilling Co.; 3 feet S. of N. yard fence, 10 feet W. of E. yard fence, and 6 feet W. of 15-inch blazed oak tree. Elevation: Bolt in slab, 489.394; cap on pipe, 493.444.

P. B. M. No. 3.—Concrete slab and iron pipe on L. B.; about 7.4 miles below Terre Haute, Ind.; about 325 feet E. of river bank on the Theo. Hullman farm (George Cramer, tenant); in fence corner about 3 feet E. of N. and S. road fence and about 5 feet S. of E. and W. barnyard fence; about 245 feet W. from dwelling house. Lat., 39° 24′+3,326.3; long., 87° 27′+4,677.1. Elevation: Bolt in slab, 483.901; cap on pipe, 487.966.

P. B. M. No. 4.—Concrete slab and iron pipe on L. B., about 10 miles below Terre Haute, Ind.; 1.25 miles below Prairieton; about 1 mile back from river; on N. side of road leading W. from Prairieton, Ind., through the Blue Hole (local name) to river; on W. side of road leading from above-described road out to river; at SE. corner of cultivated field owned by John Rotz; about 100 feet N. of small dwelling occupied (1911) by George McCoy; 3 feet inside of E. fence and 4 feet inside of S. fence. Elevation: Bolt in slab, 467.982; cap on pipe, 472.029.

P. B. M. No. 5.—Concrete slab and iron pipe on L. B., about 17.2 miles below Terre Haute, Ind.; about 0.25 miles below lower end of Strains Ripple, on farm of S. A. Paddock; about 16 feet S. of center line of road; 3 feet S. of yard and road fence and immediately at junction of yard and garden fences; about 325 feet E. of "The White School House" (local name); about 100 feet N. of NE. corner of dwelling house on said farm; about 40 feet S. of base of E. and W.

levee, which follows along top of river bank at this point. Elevation: Bolt in slab, 451.478; cap on pipe, 455.516.

P. B. M. No. 6.—Concrete slab and iron pipe on L. B., about 20.4 miles below Terre Haute, Ind.; about 600 feet, above upper end of Aurora Bend; about 50 feet E. of road running near outside of levee, said road leading to Darwin, Ill. In front yard of house of Fred Maurer; 12 feet W. of NW. corner of house. Lat., 39° 16′+6,019.5; long., 87° 36′+2,500.9. Elevation: Bolt in slab, 451.222; cap on pipe, 455.290.

P. B. M. No. 7.—Concrete slab and iron pipe on L. B., about 24.4 miles below Terre Haute, Ind., opposite Darwin, Ill.; about 25 feet E. of center of road at the point where it turns down the high bank to Darwin Ferry; pipe is near the center of a square formed by four blazed cottonwood trees which stand as follows: SW. 33 feet, SE. 30 feet, NW. 37 feet, and NE. 31 feet. Elevation: Bolt in slab, 447.163; cap on pipe, 451.148.

P. B. M. No. 8.—Concrete slab and iron pipe on R. B., about 29.8 miles below Terre Haute, Ind.; about 330 feet W. of river bank, at upper end of Chenoweths Reach; 16 feet W. of road which runs approximately N. and S. at this point; in fence corner formed by yard and poultry fences; about 65 feet SE. of SE. corner of a two-story green brick house belonging to M. C. Chenoweth. Lat., 39° 14′+2,572.7; long., 87° 34′+3,609.7. Elevation: Bolt in slab, 454.472; cap on pipe, 458,541.

P. B. M. No. 9.—Concrete slab and iron pipe on R. B., about 33.3 miles below Terre Haute, Ind.; about 165 feet from top of river bank, in SE. corner of barnyard of G. H. Whitlock; about 100 feet E. of SE. corner of dwelling house of G. W. Whitlock; about 60 feet W. of a 24-inch blazed water maple tree. Lat., 39° 11′+4,994.4; long., 87° 35′+3,756.1. Elevation: Bolt in slab, 444.345; cap on pipe, 448.387.

P. B. M. No. 10.—Concrete slab and iron pipe on R. B., about 37.2 miles below Terre Haute, Ind., at York, Ill.; about 165 feet N. of top of river bank; in NE. corner of a vacant lot which is the SW. corner formed by the intersection of the ferry road and the first street parallel to the river; about 50 feet SW. of street intersection on property of Mrs. J. H. Rook. Lat. 39° 10′+999.3; long., 87° 38′+1,750.5. Elevation: Bolt in slab, 446.812; cap on pipe, 450.868.

P. B. M. No. 11.—Concrete slab and iron pipe on R. B., about 40 miles below Terre Haute, Ind.; about 0.25 mile SW. of mouth of Raccoon Creek, which is at a point where the river makes a very sharp bend and shows a rock ledge on the R. B. It is on the property of Oliver Meeker; about 200 feet N. of center of lane in a group of trees surrounding an old cabin; about 40 feet SE. of SE. corner of cabin and about 40 feet E. of NE. corner of a small one-room building. Blazed trees: 16-inch sycamore, NE. 16 feet; split-bodied water maple, W. 16 feet. Lat., 39° 08′+214.8; long., 87° 39′+3,177.2. Elevation: Bolt in slab, 451.951; cap on pipe, 455.994.

P. B. M. "Hutsonville."—Center of chiseled square, at Hutsonville, Ill.; on R. B., about 44 miles below Terre Haute, Ind.; in N. end of lowest stone step of W. or main entrance to public-school building, marked U. S.□B. M. Elevation, 451.894.

P. B. M., No. 12.—Concrete slab and iron pipe on R. B., about 42.7 miles below Terre Haute, Ind.; in SW. corner of public-school yard, about 2 blocks W. and one-half block S. from ferry landing; about 3 feet E. of E. edge of sidewalk and 2 feet N. of E. & W. property fences. Lat., 39° 06′+2,622.3; long., 87° 39′+1,752.9. Elevation: Bolt in slab, 447.680; cap on pipe, 451.740.

P. B. M. No. 13.—Concrete slab and iron pipe on R. B., about 46.4 miles below Terre Haute, Ind.; about 250 feet W. of river bank; on W. side of road along levee which runs NW. and SE. at this point; about 130 feet S. of point where road turns E. to Harneys Ferry; on property of John Colliflower; about 150 feet E. of the SE. corner of his dwelling house; about 3 feet S. of his S. garden fence; 2 feet W. of road fence; 10 feet N. of a small apple tree. Lat., 39° 04′+5,930.0; long., 87° 37′+560.2. Elevation: Bolt in slab, 438.126; cap on pipe, 442.181.

P. B. M. "Plunkett."—Cross in center of chiseled square on R. B., opposite Merom, Ind.; about 49.6 miles below Terre Haute, Ind.; on S. end of lowest step of flight 8 steps leading to porch of dwelling of J. E. Plunkett. House stands about 130 feet back from top of high bank. P. B. M. is 50 feet N. of road leading down to Merom Ferry. Letters "U. S. B. M." cut on step. Elevation: 438.967.

P. B. M. No. 14.—Concrete slab and iron pipe on R. B., opposite Merom, Ind., and about 49.6 miles below Terre Haute, Ind.; about 200 feet back from top of

high bank; about 100 feet W. of dwelling house of J. E. Plunkett; in SE. corner of garden; about 25 feet N. of road leading down to Merom Ferry. Pipe was disturbed by drift during high water of 1913. Lat. 39° 03′+2.653.4; long., 87° 34′+2,135.6. Elevation: Bolt in slab, 435.341; cap on pipe, 439.397.

P. B. M. "Riverton."—Center of 2-inch chiseled square at Riverton, Ind.; on L. B., about 52.4 miles below Terre Haute, Ind.; in top of concrete abutment at E. end of I. C. R. R. bridge over Wabash River; on S. end of bridge-seat surface; 2 feet from face of retaining wall and 3 feet below center line of downstream chord of bridge. Letters: $\frac{\text{U. S.}}{\text{B. M.}}$ cut in masonry. Elevation, 443.097.

P. B. M. No. 15.—Concrete slab and iron pipe on L. B., about 55 miles below Terre Haute, Ind., and 1.25 miles below Greers Ripple; about 400 feet back from river bank, at point where N. and S. road turns E.; in NW. corner of yard and about 35 feet in front of cabin occupied by Judd Smith and owned by W. H. Jones; about 300 feet NW. to small iron pipe established by base-line party (1911). Lat. 38° 59′+4,200.6; long., 87° 33′+2,981.9. Elevation: Bolt in slab, 441.840; cap on pipe, 445.876.

P. B. M. No. 16.—Concrete slab and iron pipe on L. B., about 59.2 miles below Terre Haute, Ind.; about 125 miles above point formerly known as Hite's ferry; at inside base of levee, about 25 feet above where E. and W. section line road turns up river; about 20 feet above well-defined path over levee; about 150 feet below angle in levee about 400 feet above upper one of two pile hurdles in river which are about 300 feet apart. A fisherman's shack stands just outside of levee opposite P. B. M. Lat. 38° 58′+2197.7; long., 87° 31′+3319.8. Elevation: Bolt in slab, 429.255; cap on pipe, 433.310.

P. B. M. No. 17.—Concrete slab and iron pipe on L. B., about 63.4 miles below Terre Haute; about 0.75 mile above Shaws Landing; about 200 feet back from caving river bank, at upper end of growth of timber along bank; on W. side of river road; in SW. corner of garden owned by Ross Lynch, whose house stands 180 feet N. and barn stands 20 feet S. Lat., 38° 55′+2610.2; long., 87° 31′+665.6. Elevation: Bolt in slab, 425.674; cap on pipe, 429.730.

P. B. M. No. 18.—Concrete slab and iron pipe on L. B., about 65.8 miles below Terre Haute, Ind., opposite and ¾ mile above Longtown Landing; about 0.25 mile N. and 0.75 mile W. to river bank; on W. side of farm road and on N. side of second farm road; in SE. corner of apple orchard; 3 feet inside of fences; about 600 feet S. of barn. House near barn is occupied by Exin Higgins and owned by A. Black. Lat., 38° 54′+29.9; long., 87° 31′+881. Elevation: Bolt in slab, 422.994; cap on pipe, 427.016.

P. B. M. No. 19.—Concrete slab and iron pipe on L. B., about 69.3 miles below Terre Haute, Ind.; about 0.5 mile back from caving river bank (opposite bank at this point is a willow bar); on N. fence line of E. and W. gravel road leading out to river; about 650 feet E. of wooden high bridge over ditch crossing road; bridge is second one out from river; about 0.5 mile W. of N. and S. road at point where farm road turns S. and runs down to house occupied by E. E. Brown. Large cultivated field is on N. side of the gravel road. A 24-inch blazed elm tree stands W. 10 feet. Lat., 38° 52′+259.7; long., 87° 31′+ 4466.8. Elevation: Bolt in slab, 417.826; cap on pipe, 421.817.

P. B. M. No. 20.—Concrete slab and iron pipe on R. B., about 74 miles below Terre Haute, Ind., at Russellville, Ill.; about 300 feet from river bank; in SW. corner of lot owned by James Broyle; on E. side of public road leading N. to Palestine, Ill., and S. to Vincennes, Ind., about 100 feet above point where road turns E. to ferry; just across road from townhouse; about 30 feet NW. of frame house that stands at corner; about 35 feet N. to 30-inch cottonwood tree; about 30 feet S. to 40-inch maple tree. Lat. 38° 49′+168.7; long., 87° 31′+3569.2. Elevation: Bolt in slab, 427.539; cap on pipe, 431.611.

P. B. M. No. 21.—Concrete slab and iron pipe on R. B., about 78.5 miles below Terre Haute, Ind.; about 5 miles below Russellville, Ill.; about 0.25 mile below point formerly known as Belgrade Landing; on E. side of Russellville-Vincennes main public road; about 0.75 mile below schoolhouse; about 125 feet SW. of house owned and occupied by W. H. Wathem; 2 feet inside of property-line fence; in line with fence separating barnyard and lawn. Lat. 38° 46′+1404.2; long. 87° 31′+761.6. Elevation: Bolt in slab, 422.642; cap on pipe, 426.688.

P. B. M. No. 22.—Concrete slab and iron pipe on R. B., about 83.6 miles below Terre Haute; about 3 miles above Vincennes, Ind.; about 150 feet back

from bank, on inside face of levee, 4 feet from top; 15 feet N. of center line of main public road at point where road crosses levee; about 0.25 mile E. of where said road turns N.; about 200 feet S. of barn with red tin roof, which is property of E. W. Hedden; 4 feet W. of E. W. Hedden's R. F. D. mail box. Lat., 38° 43′+1,492.7; long., 87° 30′+4,422.5. Elevation: Bolt in slab, 421.499; cap on pipe, 425.511.

P. B. M., B. & O., No. 1.—Cross chiseled on stone; opposite Vincennes, Ind., about 86.1 miles below Terre Haute, Ind.; on upstream end of Illinois abutment of B. & O. R. R. bridge over Wabash River; on top stone, near center; about 2 feet N. of bridge seat of first Illinois span. Marked, $\frac{U.+S.}{P.B.M.}$ Elevation, 420.667.

P. B. M., B. & O., No. 2 (B. M. No. 1, 1903 survey).—Center of chiseled square, at Vincennes, Ind.; about 86.1 miles below Terre Haute, Ind.; on top of downstream end of S. abutment of B. & O. R. R. bridge over Wabash River; marked U. S. E.

□ Elevation, 420.796.

B. M.

P. B. M. No. 1 (U. S. C. and G. S.).—The center of the top surface of the easternmost stone pier of the U. S. C. and G. S. astronomical observation station in the grounds of the Vincennes, Ind., courthouse. Elevation, 430.192.

P. B. M. "A_3" (U. S. C. and G. S.).—Square cut in water table of courthouse at Vincennes, Ind.; on Seventh Street side of building; marked B. M. □ U. S. C. & G. S. Elevation, 434.108.

P. B. M. No. 2 (1903 survey).—Iron pipe and cap on L. B., about 89.2 miles below Terre Haute, Ind.; about 3.25 miles below B. & O. R. R. bridge at Vincennes, Ind.; in front of the house of Earl Meskemon; on river side of levee, near top of same. Pipe is nearly flush with slope of levee. Blazed 48-inch sycamore NE., 21 feet. Elevation, knob on cap, 419.323.

P. B. M. No. 23.—Concrete slab and iron pipe on L. B., about 89.8 miles below Terre Haute, Ind.; about 100 feet back from top of river bank; in NW. corner of orchard on Homer Henderson's place; about 3 feet E. of hedge fence and 3 feet N. of wire fence; about 15 feet E. of center line of road which runs along near base of levee; about 260 feet N. of NE. corner of Henderson's house. Lat., 38° 40′+383.1; long., 87° 35′+1,696.6. Elevation: Bolt in slab, 411.772; cap on pipe, 415.820.

P. B. M. No. 3 (1903 survey).—Iron pipe and cap on L. B., about 6 miles below B. & O. R. R. bridge at Vincennes, Ind.; about 92 miles below Terre Haute, Ind.; about 0.75 mile above mouth of the Embarras River; at lower end of small field outside of levee; about 250 paces above a small cabin on outside of levee; about 300 paces above a barn on inside of levee; near top of levee on river side of same. Elevation: Knob on cap, 420.554.

P. B. M. No. 24.—Concrete slab and iron pipe on L. B., about 93.5 miles below Terre Haute, Ind.; on farm of W. H. Brevoort estate (No. 7); in NW. corner of barn lot; just inside road fence; about 12 feet E. of center line of road which runs along near base of levee; about 60 feet S. of SW. corner of a two-story red house on said farm. Small cultivated field lies just outside of levee in front of this house. Lat., 38° 37′+2,794; long., 87° 36+4,069.5. Elevation: Bolt in slab, 406.242; cap on pipe, 410.243.

P. B. M. "Big Four" (B. M. No. 5. 1903 survey).—Center of 1 inch chiseled square, about 95.9 miles below Terre Haute, Ind.; about 3.5 miles above St. Francisville, Ill.; in top of downstream end of second pier, L. B. end of Big Four railroad bridge over Wabash River; letters: U. S.□B. M., cut on pier. Elevation, 416.834.

P. B. M. No. 25.—Concrete slab and iron pipe on L. B., about 97.8 miles below Terre Haute, Ind.; about 1.5 miles above St. Francisville. Ill., on top of a narrow sand ridge which shows clearly on contour of shore line; about 250 feet SE. of center line of road at point where it crosses ridge; about 20 feet W. of a triple-bodied blazed elm tree which stands in swale. Lat., 38° 35′+1,031; long., 87° 36′+4,052.1. Elevation: Bolt in slab, 409.970; cap on pipe, 414.007.

P. B. M. No. 26.—Concrete slab and iron pipe on L. B., about 102.4 miles below Terre Haute, Ind.; about 3 miles below St. Francisville, Ill., in NE. corner of yard of residence of John Rainey, whose house is a two-story, white-frame one, standing in angle of road; about 15 feet S. of center line of E. and W. road and immediately inside of yard fence; about 35 feet NE. of NE. corner

of house. Lat., 38° 33′+1,248.3; long., 87° 39′+1,000.1. Elevation: Bolt in slab, 402.014; cap on pipe, 406.067.

P. B. M. No. 27.—Concrete slab and iron pipe on L. B., about 106.8 miles below Terre Haute, Ind.; about 2.75 miles above Little Rock, Ind.; about 40 feet from top of bank; in NW. corner of garden plot of caretaker's house on property of Wabash Fishing Club; about 2 feet E. of E. end of heavy wrought-iron fence in front of said property; about 30 feet E. of 18-inch blazed hickory tree. Lat., 38° 30′+1.162.5; long., 87° 38′+4,711.7. Elevation: Bolt in slab, 401.002; cap on pipe, 405.039.

P. B. M. No. 10 (1903 survey).—Iron pipe and cap on L. B., about 109.1 miles below Terre Haute, Ind., at Little Rock, Ind., P. O.; in lane where the road leaves the river; about 20 paces E. of the public scales and at the W. end of a corncrib; 40 feet E. of mail box of Edward Self. Lat., 38° 29′+4,121.3; long., 87° 40′+3,481.2. Elevation: 403.493.

P. B. M. No. 28.—Concrete slab and iron pipe on L. B., about 111.4 miles below Terre Haute, Ind.; about 2.5 miles below Little Rock, Ind.; about 25 feet from top bank of river; in NE. corner of yard of residence of Perry Cunningham, which is a 1½-story white house standing about 65 feet S. of river bank; in SW. corner of a road (S. and E. and W.); just inside of yard fence; about 45 feet NE. of NE. corner of house; about 25 feet W. of center line of S. road at junction; about 10 feet S. of E. and W. road at its nearest point. Lat., 38° 28′+4.210.9; long., 87° 42′+3,864.6. Elevation: Bolt in slab, 401.409; cap on pipe, 405.462.

P. B. M. No. 29.—Concrete slab and iron pipe on L. B., about 115.6 miles below Terre Haute, Ind.; about 4 miles above Mount Carmel, Ill.; about 1.75 miles above Grand Rapids Lock, on land of James Carson (Reuben Reed, tenant); in front of and directly in line with S. side of a small subtenant house which stands on a high mound and is about 0.25 mile below bridge over a main drainage ditch; about 650 feet below a smaller ditch; about 15 feet W. of SW. corner of house; 15 feet E. of center line of road which runs along top bank of river; 6.5 feet NE. of blazed walnut tree. (Old B. M. probably of a levee or geological survey shows on E. root of blazed walnut tree.) Lat., 38° 27′+1,970.5; long., 87° 44′+718.7. Elevation: Bolt in slab, 401.465; cap on pipe, 405.498.

P. B. M. No. 12 (1903 survey).—Iron pipe and cap on L. B., about 115.5 miles below Terre Haute, Ind.; about 0.5 mile below a point opposite Hanging Rock; nearly opposite the lower end of a small island; about 1.5 miles above the Grand Rapids Lock and Dam; exactly on fence line; 90 paces below the bridge over a ditch; about 15 feet NE. of center line of road; halfway between two drainage ditches; about 30 feet NE. of blazed 24-inch black oak tree. Elevation: Knob on pipe cap, 397.699.

(U. S. G. S. B. M.) P. B. M. No. 13 (1903 survey).—A point where the coping stones meet near the upper heel post on the land wall of the Grand Rapids Lock; about 117.3 miles below Terre Haute, Ind., and 2 miles above Mount Carmel, Ill. Elevation: Knob on cap, 397.122.

P. B. M. "Grand Rapids."—Center of 1 inch square sunk in masonry; about 117.3 miles below Terre Haute, Ind., and about 2 miles above Mount Carmel, Ill.; near point where three coping stones meet near the upper heel post on land wall of the Grand Rapids Lock. Marked: □ U. S. P. B. M. Lat., 38° 26′+747.3; long., 87° 44′+1,832.5. Elevation: 397.116.

P. B. M. No. 30.—Concrete slab and iron pipe on L. B., about 120 miles below Terre Haute, Ind.; about 500 feet back from river bank; about 525 feet below Southern Railroad bridge across Wabash River from Mount Carmel; about 25 feet from upstream river corner of house occupied by C. G. Patry (George Combs, owner); on outside of river road leading downstream from ferry. Lat., 38° 23′+5,188.9; long., 87° 45′+262.9. Elevation: Bolt in slab, 391.505; cap on pipe, 395.538.

P. B. M. No. 15 (1903 survey).—Iron pipe and cap on L. B., about 122 miles below Terre Haute, Ind.; about 0.5 mile below the foot of Patoka Island; about 0.25 mile above the cable ferry; 30 paces below the front gate of Anton Beuligman's yard and on the river side of the fence, close to same. Elevation: Knob on pipe cap, 392.329.

P. B. M. No. 31.—Concrete slab and iron pipe on L. B., about 124.2 miles below Terre Haute, Ind.; about 4.25 miles below Mount Carmel, Ill.; about 150 feet from river bank on outside of river road; in front of small house occupied by Andrew Walden (Charles Kenton, owner); 1 foot inside of fence line. Barn on

high mound stands 200 feet above house. Lat., 38° 21′+3,384.3; long., 87° 48′+2,118.3. Elevation: Bolt in slab, 386.839; cap on pipe, 390.864.

P. B. M. No. 17 (1903 survey).—Iron pipe and cap on L. B., about 125.7 miles below Terre Haute, Ind., opposite Rochester, Ill.; at the anchor of the ferry cable and on the river side of fence. Elevation: Knob on cap, 390.418.

P. B. M. No. 32.—Concrete slab and iron pipe on L. B., about 128.8 miles below Terre Haute, Ind.; about 3 miles below cable ferry at Rochester, Ill.; about 1 mile above Crowleyville, Ind., in NW. corner of yard of house occupied by Jordan Garrett; about 250 feet below barn with red tin roof; 3 feet inside of fences; about 30 feet from hickory tree (top broken out) standing at top of river bank; about 150 feet above P. B. M. No. 18 (1903 survey). Lat., 38° 17′+5,628.0; long., 87° 49′+3,602.2. Elevation: Bolt in slab, 386.047; cap on pipe, 390.120.

P. B. M. No. 18 (1903 survey).—Iron pipe and cap on L. B., about 128.8 miles below Terre Haute, Ind.; about 1 mile above Crowleyville, Ind.; about 0.25 mile above church house, on river side of a fence, and at intersection of road fence and fence on lower side of a garden; 30 feet below residence of Jordan Garrett; about 150 feet below P. B. M. No. 32. Elevation: Knob on cap, 388.974.

P. B. M. No. 33.—Concrete slab and iron pipe on L. B., about 132.6 miles below Terre Haute, Ind.; about 1 mile below Jimtown, Ind.; about 125 feet back from top of bank; about 0.5 mile below ruins of old sorghum mill; 3 feet inside of fences; in SE. corner of garden plot; 40 feet in front of house occupied by Allan Collins; house and all outbuildings painted white and show prominently from river. Lat., 38° 17′+1,093.2; long., 87° 52′+301.4. Elevation: Bolt in slab, 383.852; cap on pipe, 387.835.

P. B. M. No. 20 (1903 survey).—Iron pipe and cap on L. B., about 135.6 miles below Terre Haute, Ind.; about 1 mile below McCrearys Bluff; on the river side of road; about 0.25 mile above a large white house standing back of the open bluff bank; about 50 paces below a small house. Elevation: Knob on cap, 386.771.

P. B. M. No. 34.—Concrete slab and iron pipe on L. B., about 136.4 miles below Terre Haute, Ind.; about 1.75 miles below McCrearys Bluff; about 400 feet from river bank on S. side of east-and-west road; about 600 feet W. of schoolhouse on N. side of road; about 600 feet above small red house, which shows prominently from river; about 20 feet from NW. corner of small red house occupied by Millard Hagler; at SW. corner of yard, 3 feet inside of fences. Lat., 38° 17′+385.4; long., 87° 53′+923.9. Elevation: Bolt in slab, 381.941; cap on pipe, 385.965.

P. B. M. No. 35.—Concrete slab and iron pipe on L. B., about 139.4 miles below Terre Haute, Ind.; about 2 miles above Seagers Island, about 800 feet from river; about 100 feet S. of farm road at top of high bank and running W. past Seager's place; about 100 feet W. of prominent red barn on high mound; about 20 feet SE. of small house; at corner of yard; 3 feet inside of fences; about 20 feet W. of small iron pipe established by base-line party (1911). Lat., 38° 17′+427.3; long., 87° 55′+604.6. Elevation: Bolt in slab, 380.524; cap on pipe, 384.562.

P. B. M. No. 22 (1903 survey).—Iron pipe and cap on L. B., about 142.2 miles below Terre Haute, Ind.; about 0.25 mile below the foot of Seagers Island, on top of river bank; between a house and corn crib; 205 feet from the house and 86 feet from the crib. Lat., 38° 17′+673.3; long., 87° 56′+558.2. Elevation: Knob on cap, 380.619.

P. B. M. No. 36.—Concrete slab and iron pipe on L. B., about 144.6 miles below Terre Haute, Ind., about 4.5 miles above Grayville, Ill., about 650 feet below prominent gravel and sand bar; about 60 feet from top of bank; on E. side of river road; about 50 feet SW. of abandoned cabin; in corner of yard. about 100 feet above log corn crib; 40-inch blazed swell butted oak about 40 feet W.; two 30-inch maples and twin 30-inch sycamores stand within 100 feet of blazed tree and show prominently from river. Lat., 38° 15′+5,737.6; long., 87° 56′+2,144. Elevation: Bolt in slab, 378.387; cap on pipe, 382.441.

P. B. M. No. 23 (1903 survey).—Iron pipe and cap on L. B., about 145.3 miles below Terre Haute, Ind.; about 3 miles below Seagers Island; just above a clump of timber; about 178 feet NE. of a house; in NE. corner of garden; inside fence (4 feet from caving bank, 1911). Lat., 38° 15′+2,144.3; long., 87° 56′+3,894.3. Elevation: Knob on cap. 381.852.

P. B. M. No. 37.—Concrete slab and iron pipe on L. B., about 147.6 miles below Terre Haute, Ind.; opposite Grayville, Ill.; about 500 feet from river bank above Grayville and about 0.25 mile from river bank below Grayville;

about 60 feet back of levee, in cultivated field; at intersection of Y road leading along outside of levee and road leading down river to Griffiin, Ind. Third road leads to Grayville ferry; 40 feet W. to 12-inch blazed coffee-bean tree. Lat., 38° 14′+3,252.8; long., 87° 58′+2,185.1. Elevation: Bolt in slab, 375.346; cap on pipe, 379.389.

P. B. M. No. 25 (1903 survey).—(U. S. G. S. B. M.) Center of chiseled square in masonry; about 151.1 miles below Terre Haute, Ind.; about 1.75 miles below Grayville, Ill., on downstream end of W. left bank pier of I. C. R. R. bridge.

Marked: U. S. E. □ B. M. Elevation: 389.538.

P. B. M. No. 38.—Concrete slab and iron pipe on L. B., about 155.1 miles below Terre Haute, Ind.; about 3.5 miles above New Baltimore, Ind.; about 0.25 mile back from river; about 125 feet E. of center line of road along top of high bank (road leads along to New Harmony, Ind.); about 30 feet NE. of small house; in NW. corner of garden plot on land of R. Brooks; about 15 feet N. of small iron pipe established by base-line party (1911). Elevation: Bolt in slab, 377.080; cap on pipe, 381.089.

P. B. M. No. 39.—Concrete slab and iron pipe on L. B.. about 159 miles below Terre Haute, Ind.; about 4 miles above New Harmony, Ind.; about 300 feet back from river bank; about 40 feet above R. B. of Black River; about 325 feet S. of highway bridge across Black River; about 100 feet N. of small house owned and occupied by D. M. Ades; in NE. corner of back yard; 3 feet inside of fences. Lat., 38° 10′+3508.5; long., 87° 55′+772.9. Elevation: Bolt in slab, 379.625; cap on pipe, 383.624.

P. B. M. No. 28 (1903 survey).—Iron pipe and cap on L. B., about 160.6 miles below Terre Haute, Ind.; about 3 miles above New Harmony, Ind.; about 30 feet from top of river bank; near the large white house of Link Ford; on N. side of fence; about 75 feet from S. end of the house; about 50 feet from the fence corner. Elevation: Knob on cap, 378.973.

P. B. M. "Bank."—(U. S. G. S. B. M.) Bronze tablet marked "392 Vin"; about 162.9 miles below Terre Haute, Ind.; at New Harmony, Ind.; in center of N. window sill of New Harmony Banking Co.'s building. Elevation: 384.875.

P. B. M. "Library."—(U. S. G. S. B. M.) Bronze tablet stamped "387 Vin"; about 162.9 miles below Terre Haute, Ind., at New Harmony, Ind.; at N. side of entrance of Murphy Library; at W. end of top step. Elevation: 387,406.

P. B. M. "New Harmony, 1903."—Iron pipe and cap on L. B., about 163 miles below Terre Haute, Ind., on top of second high bank; at lower edge of the town of New Harmony, Ind.; 78 feet S. of W. end of Steam Mill Street; close to wire fence; on W. side of alley; just back of the house of LeRoy Cox; 6 feet N. of Capt. Ribeyre's red barn; about 50 feet above P. B. M. No. 40, and on opposite side of alley. Lat., 38° 07′+4147.8; long., 87° 56′+1747.2. Elevation: Knob on cap, 379.331.

P. B. M. No. 40.—Concrete slab and iron pipe on L. B., about 163 miles below Terre Haute, Ind., at lower edge of town of New Harmony, Ind.; about 0.25 mile back of river bank; about 150 feet north of road leading to ferry at head of Ribeyre's Island; about 70 feet S. of W. end of Steam Mill Street; at SW. corner of yard of house of LeRoy Cox, which house fronts on Arthur Street; on E. side of alley. 20 feet E. of Capt. Ribeyre's large red barn; about 50 feet below P. B. M. "New Harmony" and on opposite side of alley. Elevation: Bolt in slab, 377.596; cap on pipe, 381.649.

P. B. M. "△ 4" (1903 survey).—Iron pipe and cap on L. B. (right bank of Ribeyre's Island); about 166 miles below Terre Haute, Ind.; about 0.5 mile below head of Turkey Island; about 160 feet from top of river bank; 12 feet W. of the N. corner of a barn; 2 feet N. of a fence running W. from the N. corner of the barn to river; about 110 feet NE. of a house where John Fisher lives; about 20 feet S. of fence corner and about 50 feet E. of corner of corncrib. Lat., 38° 06′+3756.7; long., 87° 58′+2024.9. Elevation: Knob on cap, 372.173.

P. B. M. No. 41.—Concrete slab and iron pipe on L. B.. about 167.3 miles below Terre Haute, Ind. (on R. B. of Ribeyre's Island); about 4.25 miles below New Harmony, Ind.; about 400 feet back from river; about 0.25 mile below large corncribs on river bank, on outside of road leading around island; just across road from white barn; in SW. corner of yard of two-story white house of William Hobbs (tenant); about 25 feet SW. of house. Lat., 38° 06′+2367.0; long., 87° 59′+3449.1. Elevation: Bolt in slab, 369.650; cap on pipe, 373.699.

P. B. M. "△ 10" (1903 survey).—Iron pipe and cap on L. B., (right bank of Ribeyre's Island), about 169 miles below Terre Haute, Ind.; about 5.75 miles below New Harmoney, Ind.; about 400 feet from river; about 100 feet from house where Mr. Stewart lives; about 15 feet S. from barn; about 8 feet W. from pump house; about 4 feet from fence. Lat., 38° 05′+4592.8; long., 88° 00′+3500.0. Elevation: Knob on cap, 371.235.

P. B. M. No. 42.—Concrete slab and iron pipe on L. B., about 170.4 miles below Terre Haute, Ind.; on right bank of Ribeyre's Island; about 7.25 miles below New Harmony, Ind.; about 700 feet from river, on top of high bank; about 600 feet above P. B. M. "△ 9" (1903 survey), on outside of road leading around island; about 45 feet SE. of small white house occupied by George Mitchell (tenant); in SE. corner of garden plot; 3 feet inside of fences. Lat., 38° 05′+1630.4; long., 87° 59′+463.5. Elevation: Bolt in slab, 366.322; cap on pipe 370.386 .

P. B. M. "△ 9" (1903 survey).—Iron pipe and cap on L. B. (R. B. of Ribeyre's Island); about 170.5 miles below Terre Haute, Ind.; about 40 feet from top of high bank; on inside of road along top of bank; 30 feet from its center line; about 600 feet below P. B. M. No. 42; about 100 feet below vacant house, in cultivated field. Road turns into cornfield between house and P. B. M. "△ 9." Lat., 38° 05′+1,821.8; long., 87° 59′+4,698.5. Elevation: Knob on cap, 369.649.

P. B. M. No. 43.—Concrete slab and iron pipe on L. B., about 173.6 miles below Terre Haute, Ind.; about 10.5 miles below New Harmony, Ind.; about 0.5 mile above head of Mink Island; just above Winkler's ferry; at top of river bank; inside of ferry road; blazed 12-inch box elder S. 8 feet; blazed 24-inch sycamore W. 12 feet. Lat., 38° 05′+3,040.4; long., 87° 57′+1,273.2. Elevation: Bolt in slab, 364.034; cap on pipe, 368.077.

P. B. M. No. 44.—Concrete slab and iron pipe on L. B., about 177.4 miles below Terre Haute, Ind.; about 3 miles above Maunie, Ill.; about 200 feet above foot of Twin Sister Island No. 1; about 100 feet from top of river bank; about 6 feet W. of N. and S. wire fence dividing cultivated fields; blazed 16-inch walnut tree S. 20 feet; blazed 6-inch thorn tree NW. 10 feet; blazed 10-inch thorn tree NW. 20 feet. Lat., 38° 03′+25.6; long., 87° 59′+3,845.1. Elevation: Bolt in slab, 362.890; cap on pipe, 366.964.

P. B. M. "Aldrich."—Iron pipe and cap on L. B., about 179.9 miles below Terre Haute, Ind.; about 0.5 mile above Maunie, Ill.; about 600 feet from river; about 8 feet N. of the NE. corner of big red barn on high mound on land of John Aldrich; about 3 feet W. of B. M. 102 established by base-line party (1911). Elevation: Knob on cap, 372.949.

P. B. M. No. 31 (1903 survey).—Iron pipe and cap on L. B., about 182 miles below Terre Haute, Ind.; about 0.75 mile above the head of Grand Chain; about 40 feet from upstream river, corner of large tenement house on river side of road; about 25 feet from iron pump in back yard; near two pecan trees at right angles to river. Elevation: Knob on cap, 359.528.

P. B. M. "L. & N."—Center of depressed chiseled square in masonry; about 183.7 miles below Terre Haute, Ind.; about 3 miles below Maunie, Ill., on land pier (L. B.) of L. & N. R. R. bridge over Wabash River; on upstream end of pier and on top of same; marked U. S. □ B. M.; about 1.5 feet above iron base plate; about 3 feet from upstream end and about 3.5 feet from sides of top course of masonry. Elevation, 373.828.

P. B. M. No. 45.—Concrete slab and iron pipe on L. B., about 183.7 miles below Terre Haute, Ind.; at L. & N. R. R. bridge, about 3 miles below Maunie, Ill.; about 175 feet back from land pier; 15 feet below center line of trestle. Lat., 38° 01′+535.9; long., 88° 01′+644.7. Elevation: Bolt in slab, 358.602; cap on pipe, 362.625.

P. B. M. "Illinois."—(U. S. G. S. B. M.) Aluminum tablet stamped; "375-Illinois-1903," at Maunie Ill., about 180.5 miles below Terre Haute, Ind.; in middle of NW. face of foundation wall to Methodist Church, 2 feet above ground. Elevation, 375.703.

P. B. M. No. 33 (1903 survey).—Iron pipe and cap on L. B., about 185.4 miles below Terre Haute, Ind.; about 1.75 miles below L. & N. R. R. bridge; in line with upper side of steel tower for supporting telephone wires across river; 30 feet out (toward river) from base of tower. Lat., 37° 59′+4,617.4; long., 88° 01′+623.4. Elevation: Knob on cap, 361.163.

P. B. M. No. 46.—Concrete slab and iron pipe on L. B., about 188.3 miles below Terre Haute, Ind.; about 7.5 miles below Maunie, Ill.; about 100 feet

from river bank; about 100 feet above head of cut-off; about 0.25 mile above Little Chain; about 30 feet SW. of SW. corner of small red house occupied (part of year) by Herman Jeffries. Lat., 37° 57′+3,165.0; long., 88° 01′+2,686.4. Elevation: Bolt in slab, 357.098; cap on pipe, 361.112.

P. B. M. No. 47.—Concrete slab and iron pipe on L. B., about 192.1 miles below Terre Haute, Ind.; about 200 feet above Fretageot's Ferry Landing; about 250 feet from river, on outside of road leading to Mount Vernon, Ind.; about 400 feet below angle in road where it turns away from river; 30 feet from center line of road; 3 feet inside of fence line of wooded pasture; about 400 feet above small iron pipe established by base line party (1911); about 30 feet S. of door in end of long shed; blazed white oak tree, W. 85 feet. Elevation: Bolt in slab, 359.925; cap on pipe, 363.952.

P B. M. No. 48.—Concrete slab and iron pipe on L. B., about 196 miles below Terre Haute, Ind.; about 3.25 miles above mouth of Little Wabash River; about 250 feet from river; on land side of road on top of high bank; in NE. corner of yard; 3 feet inside of fences; about 18 feet NE. of NE. corner of small white house occupied by R. D. Walling, which is in plain view of river; about 200 feet above small iron pipe established by base line party (1911). Lat., 37° 53′+2,299.2; long., 88° 03′+1,468.6. Elevation: Bolt in slab, 362.625; cap on pipe, 366.663.

P. B. M. No. 49.—Concrete slab and iron pipe on L. B., about 200.6 miles below Terre Haute, Ind.; about 1 mile below mouth of Little Wabash River, about 800 feet from river; on top of high bank; about 60 feet SW. of SW. corner of rail corn crib with high roof (crib on high mound and in plain view from the river); 3 feet inside of wire fence; about 90 feet S. of small iron pipe established by base line party (1911); blazed 15-inch red oak tree, S. 10 feet; blazed 8-inch pig hickory tree N. 12 feet. Elevation: Bolt in slab, 359.962; cap on pipe, 364.029.

P. B. M. No. 50.—Concrete slab and iron pipe on L. B., about 204.4 miles below Terre Haute, Ind.; about 10 miles above mouth of Wabash River; about 1 mile above Levi's Slough; about 800 feet from river; in corner of yard; about 35 feet W. of NW. corner of house owned and occupied by Ferd. Vollmer; on S. side of E. & W. section line road; 20 feet from center line of road Two sheds and barn are on opposite side of road. Buildings are on high ground and are in plain view from river. Lat., 37° 50′+5,238.1; long., 88° 02′+180.3. Elevation: Bolt in slab, 357.586; cap on pipe, 361.635.

P. B. M. No. 39 (1903 survey).—Iron pipe and cap on L. B., about 206.6 miles below Terre Haute, Ind.; about 1.25 miles below Bone Bank; about 40 feet from river, between large white locust and large hackberry trees at lower edge of small strip of large trees; opposite upper end of Mackeys Bar, which is above island of same name; on river side of wagon road; small mound and shack stand on outside of road nearby. Lat., 37° 49′+1,244.3; long., 88° 02′+2538.0. Elevation: Knob on cap, 349.316.

P. B. M. No. 51.—Concrete slab and iron pipe on L. B., about 207.9 miles below Terre Haute, Ind.; about 6.5 miles above mouth of the Wabash River; about one-half mile below Mackeys Island; about 150 feet from top of caving bank; on land of Mackey heirs; about 40 feet S. of SW. corner of small tenant house; in NW. corner of barn lot; 3 feet inside of fences; about 100 feet E. of high mound; blazed 48-inch pecan tree W. 20 feet; 60-inch elm N. 40 feet; 40-inch cottonwood NW. 40 feet. Elevation: Bolt in slab, 343.865; cap on pipe, 347.944.

P. B. M. No. 52.—Concrete slab and iron pipe on L. B., about 213.8 miles below Terre Haute, Ind.; about 0.75 mile above mouth of Wabash River; about 900 feet from river bank: in cultivated land at intersection of road across neck and road leading down river; about 0.75 mile above prominent corncrib on high concrete-faced mound, on property of Crumback; about 1,000 feet N. of shack near top of bank; about 0.25 mile E. of shack at turn in road; blazed 24-inch pecan tree SW. 10 feet; blazed 24-inch pecan tree W. 125 feet. Elevation: Bolt in slab, 337.912; cap on pipe, 341.973

P. B. M. No. 53.—Concrete slab and iron pipe on Wabash Island; opposite mouth of Wabash River; 214.8 miles below Terre Haute, Ind.; on right side of island; at open place used as fisherman's landing; about 125 feet from low-water bank; about 450 feet above road leading across island. Elevation: Bolt in slab, 345.405; cap on pipe, 349.440.

P. B. M. No. 54.—Concrete slab and iron pipe on L. B. of Ohio River; about 0.75 mile below head of Wabash Island; about 300 feet above mouth of Lost

Creek; about 0.3 mile below wagon bridge across Lost Creek; on high ground about 0.25 mile back from willow line along river; about 300 feet out (toward river) from base of hills; in SE. corner of garden plot; about 50 feet S. from SE. corner of barn; about 200 feet NE. from house owned and occupied by H. R. Slack; 3 feet inside of garden fences. Lat., 37° 46′+4,071.0; long., 88° 00′+267.2. Elevation: Bolt in slab, 372.333; cap on pipe, 376.330.

P. B. M. No. 839 (Ohio River survey).—Iron pipe and cap on L. B. of Ohio River, about 800 feet below head of Wabash Island, on slope among trees, about 50 feet from edge of cultivation; pipe 2.5 feet underground (1911).

Blazed tree, 4-inch sycamore, 231° 23′, 15.84 feet.
Blazed tree, 12-inch sycamore, 274° 40′, 43.47 feet.
Blazed tree, 347° 54′, 14.43 feet.
Elevation: Knob on cap, 340.458.

P. B. M. No. 842 (Ohio River survey).—Iron pipe and cap on L. B. of Ohio River, on top of slope among trees, about 1,200 feet below Government light at foot of Wabash Island, about 50 feet from edge of cornfield.

Blazed 12-inch sycamore (nail) 4° 10′, 31.01 feet. Old blazes.
Blazed 10-inch sycamore (nail) 21° 33′, 34.36 feet. Old blazes.
Blazed 10-inch sycamore (nail) 339° 55′, 32.33. Old blazes.
Blazed 6-inch maple NE., 18 feet.
Blazed 10-inch cottonwood W., 30 feet.
Blazed 8-inch maple E., 27 feet.
Elevation: Knob on cap, 338.819.

P. B. M. "Kentucky."—(U. S. G. S. B. M.) Iron post stamped "1906" on L. B. of Ohio River, at Blackburn, Ky., opposite Shawneetown, Ill., at SW. corner of abandoned store building, in NE. corner of crossroads.

Elevation: 348.150.

P. B. M. "Riverside."—(U. S. G. S. B. M.) Aluminum tablet stamped "1906" at Shawneetown, Ill., 100 feet E. of SE. corner of Riverside Hotel, in NE. corner of gunrack.

Elevation: 366.419.

P. B. M. "Station."—(U. S. G. S. B. M.) Iron post stamped "1906" at Shawneetown, Ill., at SW. corner of L. & N. R. R. station.

Elevation: 350.168.

APPENDIX D.

TRAVERSE BENCH MARKS ALONG WABASH RIVER, TERRE HAUTE TO MOUTH.

These bench marks are situated, in general, along the river banks, their maximum distance therefrom being about 1 mile. From Terre Haute, Ind., to Darwin, Ill., they follow the left or Indiana bank; thence to Merom, Ind., they follow the right or Illinois bank; thence to Russellville, Ill., the left bank; thence to Vincennes, Ind., the right bank; thence to the foot of Ribeyres Island, Ind., the left bank; thence to Maunie, Ill., the right bank; thence to the mouth, the left bank.

The latitudes and longitudes were determined by a careful traverse line, measured forward and backward with steel tape, limit of closure 1:15000, and azimuth, the mean of six angles frequently checked by star observations, using a triangulation, 10 second transit. The line was adjusted between U. S. G. S. primary traverse station 22 at Terre Haute, Ind., and U. S. C. & G. S. station Merom College at Merom, Ind., and between the latter station and U. S. C. & G. S. astronomical station at Vincennes, Ind. No adjustment was made below Vincennes, Ind.

Elevations were determined by careful duplicated ordinary level connections with the precise level bench marks of this survey (1911), whose elevations are based on the 1907 value of the U. S. C. & G. S. B. M. A_3 at Vincennes, Ind., i. e., 434.108 feet above sea level.

Azimuths to permanent objects are given for the convenience of surveyors.

The descriptions have been taken from the field note books without revision and are not final, as the party is still in the field. The distances below Terre Haute, Ind., therein are river distances.

Respectfully submitted.

GEO. H. WOLBRECHT,
Assistant Engineer.

MOUNT CARMEL, ILL., *July 20, 1912.*

B. M. No. 1.—A 2-inch iron pipe about 1 mile above Union Station at Terre Haute, Ind., on S. side of Sixth Avenue, about 8 feet E. of C. & E. I. track.

	°	′	″
To church spire	31	08	30
To church spire	26	31	30
To church spire	26	00	30
To depot	20	20	30

Lat., 39° 28′+5,935.81; long.. 87° 23′+4,273.35. Elevation, 492.87.

B. M. No. 2.—A 2-inch iron pipe at SE. corner of reservoir at Terre Haute waterworks, 1.5 feet from stone corner post.

	°	′	″
To spire, Union Station	286	24	30
To spire, courthouse	350	43	30
To crematory smokestack, R. B	35	14	30
To NE. corner waterworks' brick smokestack	59	34	30

Lat., 39° 28′+3,622.01; long., 87° 25′+80.15. Elevation, 502.67.

B. M. No. 3.—A 2-inch iron pipe in Terre Haute, NE. corner of Water and Swan Streets. In SW. corner of yard of gas company, about 1 foot from brick retaining wall.

	°	′	″
To NW. corner of People's Brewery	346	37	00
To E. stack of four iron stacks at distillery on L. B	8	11	00
To NE. corner chimney of house on R. B	72	24	00
To SW. corner saloon on First Street, brick building	280	11	30

Lat., 39° 27′+4,563.60; long., 87° 25′+350.54. Elevation. 497.05.

B. M. No. 4.—A 2-inch galvanized pipe in Terre Haute, Ind., about 1 mile below highway bridge, in driveway of distillery, about 3 feet from corner of wire fence with concrete posts.

	°	′	″
To NE. corner distillery, brick	16	44	00
To crematory smokestack, R. B	159	13	30
To gable of barn, R. B	131	28	30
To gable of near red barn	241	57	30

Lat., 39° 27′+1,342.22; long., 87° 25′+508.17. Elevation, 498.55.

B. M. No. 5.—A 2-inch galvanized pipe on L. B., about 4 miles below Terre Haute, about 1 mile below Merchant's Distillery on Prairieton road on E. side of road at corner of large woods, about 7 feet from center of railroad track.

	°	′	″
To gable	271	44	00
To gable	301	18	00
To smokestack	204	15	00

Lat., 39° 26′+1,239.16; long., 87° 25′+2,655.66. Elevation, 495.40.

B. M. No. 6.—A 2-inch iron pipe on L. B., about 5.25 miles below Terre Haute on river side of road, 2 feet from wire fence; about 100 feet below house owned by W. S. Perkins.

	°	′	″
To gable of house	341	12	00
To gable of barn	351	45	00
To gable of barn	45	33	00
To gable of barn	55	32	00

Lat., 39° 25′+2,666.48; long., 87° 26′+2,669.14. Elevation, 506.44.

P. B. M. No. 3.—A 2-inch iron pipe on Theo. Hulman's farm, George Cramer, tenant; L. B. river, about 7.25 miles below Terre Haute, at a point where the river bends into within about 100 meters of road. B. M. is in fence corner 1 meter E. of N. and S. road fence and 1.5 meters S. of E. and W. barnyard fence. About 75 meters W. from dwelling house and 100 meters E. from river bank.

	°	′	″
To gable of barn	238	46	30
To gable of barn	324	02	00

Lat., 39° 24′+3,326.26; long., 87° 27′+4,677.06. Elevation, 487.97.

B. M. No. 7.—A 2-inch iron pipe on L. B.. about 10 miles below Terre Haute; about 2 miles below Eight Mile Island, 800 feet back from river bank on land

of S. E. Keever, 250 feet NW. of his house, in private lane leading to river, 200 feet W. of wagon road.

	°	′	″
To gable of old barn	280	26	30
To gable of red barn	246	25	30
To W. gable of house	234	18	00
To N. edge of chimney	243	34	00

Lat., 39° 23′+2,066.04; long., 87° 29′+716.12. Elevation, 472.19.

B. M. No. 8.—A 2-inch iron pipe on L. B., about 11.6 miles below Terre Haute; about 50 feet from river bank on top of levee; 3 miles below Eight Mile Island, on land of Henry Hahn; 500 feet upstream from an abandoned house on L. B.

	°	′	″
To S. end of roof of old house	90	27	30
To S. side of chimney, old house	91	56	30
To N. end of roof of old house	92	57	30

Lat., 39° 22′+5,626.63; long., 87° 30′+3,938.85. Elevation, 468.59.

B. M. No. 9.—A 2-inch galvanized iron pipe on L. B., 12.8 miles below Terre Haute; 1.8 miles above State line; 100 feet back from river bank on top of levee on land of Will Farmer; 30 feet above well inside of levee directly back of camp grounds.

	°	′	″
To gable of red barn	272	12	00
To brick chimney N. side	279	38	30
To gable of house	221	48	00

Lat., 39° 22′+2,034.51; long., 87° 31′+3,187.02. Elevation, 466.90.

B. M. No. 10.—A 2-inch galvanized iron pipe on L. B., about 14.5 miles below Terre Haute; about 0.25 mile above Illinois State line, intersection with river. On top of levee, 300 feet back from river on land of Harvey Bently, 200 feet above house of J. P. Hunt; public road runs along the inside of levee; 11 feet E. an 8-inch blazed elm; 15 feet S. of 12-inch blazed elm.

	°	′	″
To middle of blaze on sycamore tree, 5 feet above ground, tree on levee	265	07	00
To gable of barn across bend of river	69	52	30
To nail in blaze on 6-inch tree on levee, 6 feet from house	37	22	00

Lat., 39° 21′+206.88; long., 87° 31′+2,518.83. Elevation, 466.65.

B. M. No. 11.—A 2-inch galvanized iron pipe on L. B., about 16.3 miles below Terre Haute; on land of Mrs. J. W. Stout, on top of levee on river road; about 1.5 miles below State line; about 400 feet below abandoned log cabin. Blazed 18-inch sycamore on levee at turn of road, 178 feet.

	°	′	″
To gable of house	297	59	00
To gable of barn	300	50	30
To S. gable of barn	353	20	30

Lat., 39° 20′+3,459.56; long., 87° 32′+3,930.63. Elevation, 465.19.

B. M. No. 12.—A 2-inch galvanized iron pipe on L. B., about 2.6 miles below State line; at side of river road, on top of levee about 200 feet below white schoolhouse; on land of Carrie Mitchell; 24-inch sycamore tree on side of levee is 302° 41′ 00″. Distance, 69 feet. P. B. M. No. 5, approximately 290° azimuth. Distance, 686.2 feet. About 17.2 miles below Terre Haute.

	°	′	″
To gable of house	324	35	30
To gable of barn	357	22	00
To gable of barn	358	38	00
To gable of house	91	02	00

Lat., 39° 20′+2,095.65; long., 87° 33′+4,576.47. Elevation, 464.46.

B. M. No. 13.—A 2-inch galvanized iron pipe on L. B., about 19.4 miles below Terre Haute and about 4 miles above Darwin Ferry. On top of levee side of river road; 100 feet from river on land of Henry Maurer, about 100 feet from tenant house; about 700 feet above residence of C. C. Little.

	°	′	″
To windmill	288	14	30
To gable of barn	287	05	00
To gable of barn	248	15	30
To gable of red shed	235	33	00

Lat., 39° 19′+1,728.04; long., 87° 35′+3,662.70. Elevation 463.11.

B. M. No. 14.—A 2-inch galvanized iron pipe on L. B., about 20 miles below Terre Haute; about 3.5 miles above Darwin Ferry on top of levee; on property owned by De Kalb Fortune; about 50 feet W. of road at point of turn from W. to S. at Fortune's schoolhouse; about 90 feet NW. of Fortune's schoolhouse and 100 feet from river.

	°	′	″
To gable of house	28	21	30
To gable of barn	24	10	30
To top of roof at S. end	291	57	30

Lat., 39° 18′+4,976.97; long., 87° 36′+603.62. Elevation, 460.85.

B. M. No. 15.—A 2-inch galvanized iron pipe on L. B., about 24 miles below Terre Haute and 0.25 mile below Darwin Ferry; 800 feet back from river bank on land of J. L. Figg. In dooryard, 60 feet W. of house: 30 feet E. of public road; 20 feet E. of fence along road; granary and wagon shed across road from B. M.

	°	′	″
To gable of barn	156	27	00
To gable of house	323	52	00
To chimney of house	323	19	00
To gable of barn	228	32	00

Lat., 39° 16′+5,215.18; long., 87° 36′+1,572.57. Elevation, 450.95.

B. M. No. 16.—A 2-inch galvanized-iron pipe on R. B., about 25.5 miles below Terre Haute and about 1.5 miles below Darwin, Ill.; at Bohn Ferry 50 feet from top of river bank; in public road 50 feet in front of house of James Bohn; 5 feet N. of center line of road to ferry.

	°	′	″
To gable of barn	78	49	30
To gable of barn	112	39	00
To gable of house (L. B.)	273	52	00
To gable of barn	280	45	00

Lat., 39° 15′+3,455.49; long., 87° 36′+1,508.31. Elevation, 463.99.

B. M. No. 17.—A 2-inch galvanized-iron pipe on R. B., about 26.6 miles below Terre Haute and 3 miles below Darwin; 7 miles above York, Ill.; 500 feet from top of river bank; in dooryard of Frank Prevo, owner; 50 feet NE. of his house; 5 feet S. of E. and W. fence; 30 feet W. of N. and S. fence under cherry tree.

	°	′	″
To gable of barn	128	35	30
To middle of chimney	176	57	00
To top of E. end of roof	192	35	00

Lat., 39° 14′+5,061.69; long., 87° 35′+4,170.08. Elevation, 457.56.

B. M. No. 18.—A 2-inch galvanized-iron pipe on R. B., about 29.5 miles below Terre Haute; 6 miles below Darwin; 2.7 miles above Niles Landing; 500 feet from top of river bank; 3 feet W. of N. and S. fence along public road; 100 feet across road to house owned by Philip Rhodes (Frank Marlow, tenant).

	°	′	″
To gable of barn	63	31	00
To downstream edge of upstream chimney	64	55	00
To downstream edge of schoolhouse chimney	68	50	00

Lat., 39° 14′+1,010.58; long., 87° 34′+3,701.15. Elevation, 456.04.

B. M. No. 19.—A 2-inch galvanized-iron pipe on R. B., about 31.6 miles below Terre Haute and 5 miles above York, Ill.; one-half mile above Niles Landing and about one-fourth mile back from river bank on land owned by Arch. Davidson; in field on W. side of road leading to Niles Landing; about 75 feet SW. of fence corner; about 150 feet SW. of residence of Charles Strong; 10-inch blazed mulberry tree, 14 feet.

	°	′	″
To gable of barn	67	34	30
To gable of barn	114	46	30
To gable of house	120	50	00
To gable of house	150	55	00

Lat., 39° 12′+3,592.61; long., 87° 35′+2,316.08. Elevation, 456.46.

B. M. No. 20.—A 2-inch galvanized-iron pipe on R. B., about 34.5 miles below Terre Haute; 2 miles above York; about 150 feet back from river bank; about 150 feet W. of house of John Ingram, tenant, Mrs. Griffith, owner.

	°	′	″
To river edge of chimney just above water table	279	54	00
To base-line stake No. 89	214	06	30

Lat., 39° 11′+1,774.60; long., 87° 37′+242.63. Elevation, 445.11.

B. M. No. 21.—A 2-inch galvanized-iron pipe on R. B., about 35 miles below Terre Haute; about 1.5 miles above York; about 1,000 feet back from river bank on land of A. J. Merrying, at edge of field; 6 feet N. of center line of E. and W. road; about 150 feet E. of angling road; 60 feet E. of small plank culvert; about 250 feet E. of new mill.

	°	′	″
To downstream edge of brick chimney	85	57	00
To downstream end of shed roof	270	13	30
To base-line stake No. 91	271	10	00

Lat., 39° 11′+1,221.01; long., 87° 37′+3,368.45. Elevation, 439.42.

B. M. No. 22.—A 2-inch galvanized-iron pipe on R. B., about 36.6 miles below Terre Haute; in SW. quarter of village of York, Ill., at W. end of street that post office is on; 3 feet E. of N. and S. fence along street; about 300 feet N. of residence of S. R. Freeman, owner; about 350 feet NW. of residence of Nellie Dudley, renter.

	°	′	″
To church cupola	153	33	30
To school cupola	224	32	30
To river-edge chimney	246	34	00
To river-edge chimney	30	47	00

Lat., 39° 10′+658.69; long.. 87° 38′+2,425.86. Elevation, 448.79.

B. M. No. 23.—A 2-inch galvanized-iron pipe on R. B., about 38 miles below Terre Haute; about 1.5 miles below York; about 0.1 mile above Greens Ripple; about 700 feet back from river on bluff bank; about 100 feet from top of bank on land of Kate Root; 20-inch blazed white oak, 110 feet.

	°	′	″
To upstream edge of chimney	131	09	00
To cupola of church at York	206	06	00
To gable of house	214	08	30

Lat., 39° 09′+1,545.73; long., 87° 39′+1.009.10. Elevation, 455.26.

B. M. No. 24.—A 2-inch galvanized iron pipe on R. B. about 38.7 miles below Terre Haute; 2 miles below York; about 0.25 mile back from river on top of bluff bank; on land owned by George Musgrave; about 30 feet N. of private lane leading to river; about 500 feet E. of house rented by O. C. Scotton; owner, Levi Swinger.

	°	′	″
To south end of top of roof	89	49	00
To gable of house	91	00	00
To gable of shed	107	02	30

Lat., 39° 08′+5.538.03; long., 87° 39′+2,858.36. Elevation, 455.14.

B. M. No. 25.—A 2-inch galvanized iron pipe on R. B. about 39.5 miles below Terre Haute; about 2.5 miles above Hutsonville; about 600 feet from river; 15 feet S. of road to Rock Bar Ferry; 3 feet N. of E. and W. fence along road.

	°	′	″
To middle chimney	349	44	00
To cupola of residence at Hutsonville	8	45	00
To middle chimney	11	33	30
To gable of barn	49	02	30

Lat., 39° 08′+2.48; long., 87° 39′+2,724.65. Elevation, 455.37.

B. M. No. 26.—A 2-inch galvanized iron pipe on R. B. about 43.5 miles below Terre Haute; about 0.5 mile above ferry at Hutsonville; 15 feet S. of center line of E. and W. road leading to river, in N. part of Hutsonville; 4 feet N. of E. and W. fence along road; about 250 feet back from river bank and angle

in road; about 60 feet SW. of SW. corner of house; Sallie Ayres, renter; and George Parker, owner.

	°	′	″
To gable of barn	18	53	00
To gable of house	22	45	00
To monument in cemetery	127	27	00
To river edge of brick chimney	23	04	30

Lat., 39° 06′+5,785.64; long., 87° 39′+1,626.12. Elevation, 448.94.

B. M. No. 27.—A 2-inch galvanized iron pipe on R. B. about 44.3 miles below Terre Haute; about 0.5 mile below Hutsonville Ferry; about 0.25 mile from river at SW. corner timber; on land of Henry Wolverton; in NW. corner of field; 3 feet SE. of fence corner along N. and S. lane and along timber leading to river and along from angling road; about 0.25 mile from red barn with hexagonal cupola; on river bank about 600 feet from cannery.

	°	′	″
To cupola on Merom College	307	36	30
To downstream edge of chimney	305	15	30
To gable of barn	324	12	00
To windmill	325	04	30

Lat., 39° 06′+364.89; long., 87° 38′+4,255.24. Elevation, 456.99.

B. M. No. 28.—A 2-inch galvanized iron pipe on R. B. about 47.7 miles below Terre Haute; about 3.2 miles above Merom; about 500 feet above Harness landing; about 300 feet back from river bank on top of levee; at angle of public road; 10 feet S. of center line of lane leading over levee through open timber strip to river; 30-inch blazed locust tree. 15 feet N. on top of levee; about 4 miles below Hutsonville on land of W. J. Colliflower.

	°	′	″
To windmill	13	30	30
To gable of barn	14	36	30
To gable of house	15	18	00
To downstream edge of chimney	106	31	30

Lat., 39° 05′+600.22; long., 87° 37′+1,026.98. Elevation, 447.96.

B. M. No. 29.—A 2-inch galvanized iron pipe on R. B. about 49 miles below Terre Haute; about 2 miles above Merom; about 1 mile below Harness landing; about 250 feet back from river on top of second levee; at edge of timber strip on land of E. A. Goodman; about 0.25 mile below house owned by Fred Pierce.

	°	′	″
To gable of barn	27	24	30
To gable of barn	73	51	00
To gable of barn	79	13	00

Lat., 39° 04′+4,527.30; long., 87° 35′+4,270.08. Elevation, 446.03.

B. M. No. 30.—A 2-inch galvanized iron pipe on R. B. about 50.5 miles below Terre Haute; about 500 feet above and 0.5 mile back from Merom Ferry landing; on top of levee running N. and S. along private lane leading N. from public E. and W. road; on land of J. W. Wright; 600 feet back from river; house rented by A. E. Lane about 600 feet N.; about 8 feet S. of center line of junction of old E. and W. levee with main N. and S. levee; 25 feet SE. on old levee is dead tree snag.

	°	′	″
To Merom College spire	303	00	00
To gable of house	56	29	30
To upstream edge of chimney	56	41	30
To downstream edge of chimney	82	47	30

Lat., 39° 03′+3,295.33; long., 87° 34′+4,098.39. Elevation, 445.27.

B. M. No. 31.—A 2-inch galvanized iron pipe on R. B. about 52.2 miles below Terre Haute; about 1.5 miles below Merom Ferry; about 125 feet back from river bank on top of levee; at edge of timber strip and cult.; on land of R. J. White; about 65 feet N. of shack on levee; R. J. White, owner.

	°	′	″
To top of barn roof	121	28	00
To windmill	130	50	30
To gable of barn	131	29	00

Lat., 39° 02′+3,037.65; long., 87° 34′+4,239.75. Elevation, 441.73.

B. M. No. 32.—A 2-inch galvanized-iron pipe on L. B., about 54 miles below Terre Haute; about 600 feet below E. abutment Illinois Central drawbridge at Riverton; on E. slope of levee on land of P. H. Blue; about 35 feet NE. of houseboat shack outside of levee, residence of Richard Mack; about 50 feet SE. of houseboat shack outside of levee, residence of Arthur Meek; about 150 feet back from river.

	°	′	″
To church spire	249	12	00
To downstream edge of chimney	277	11	30
To gable of barn	325	14	30
To cupola of barn	323	30	00

Lat., 39° 01′+808.64; long., 87° 34′+359.06. Elevation, 443.69.

B. M. No. 33.—A 2-inch galvanized-iron pipe on L. B., about 56.5 miles below Terre Haute; about 2.5 miles below Riverton; about 33 feet back from river on sand knoll; about 35 feet NW. of Jim Jones's house; about 250 feet E. of shack residence of Nelson Anderson, renter; about 350 feet NW. of residence of J. N. Smith, renter; 0.5 mile above grade schoolhouse, about 300 feet NW. of iron pipe P. B. M. 15.

	°	′	″
To spire Merom College	177	02	00
To gable of barn	271	39	00
To gable of barn	214	49	30
To gable of barn	216	03	00

Lat., 38° 59′+4,475.33; long., 87° 33′+3,149.93. Elevation, 446.75.

B. M. No. 34.—A 2-inch galvanized-iron pipe on L. B., about 59.7 miles below Terre Haute; about 2 miles below Palestine Landing; about 800 feet back from river on sand ridge, 5 feet E. of center line of public road; about 75 feet N. of angle in road; about 65 feet SW. of house of George Land; barn directly W. across road; fence-rail corncrib 12 feet E.

	°	′	″
To gable of barn	196	48	00
To upstream edge of concrete silo	199	18	00
To upstream edge of chimney	203	02	30
To upstream edge of chimney	216	22	00

Lat., 38° 58′+5,201.77; long., 87° 32′+2,705.78. Elevation, 447.69.

B. M. No. 35.—A 2-inch galvanized-iron pipe on L. B., about 60.9 miles below Terre Haute; about 1 mile above Hite's Ferry on top of levee; on land of John Harlot, between mouths of two drainage ditch valves through levee; 20 feet above stone header of ditch; two pile hurdles extend into river from above mouths; about 1,600 feet below shack occupied by N. K. Wallace, about 100 feet back from river.

	°	′	″
To gable of barn	265	34	00
To upstream edge of chimney	266	22	30
To gable of house	266	51	30
To gable of barn	314	20	30

Lat., 38° 58′+825.87; long., 87° 31′+2,706.19. Elevation, 441.80

B. M. No. 36.—A 2-inch galvanized-iron pipe on L. B., about 62 miles below Terre Haute; about 4.3 miles below Palestine Landing; about 300 feet below Hites Ferry and about 200 feet back from river bank on top of levee, on land belonging to Mr. Marks; about 75 feet W. of house of Will Shepherd, renter; 60 feet S. of public road crossing levee.

	°	′	″
To river edge of chimney	172	12	00
To river edge of chimney	189	43	30
To gable of house	192	31	00
To gable of barn	219	13	00

Lat., 38° 57′+2,803.43; long., 87° 30′+3,601.61. Elevation, 441.91.

B. M. No. 37.—A 2-inch galvanized-iron pipe on L. B., about 64 miles below Terre Haute; about 2 miles below Hites Ferry and 1.3 miles above Shaws Landing; about 500 feet from river bank on top of levee; about 250 feet E. from right angle in levee.

	°	′	″
To gable of house	170	52	30
To middle window	208	45	00
To gable of pump house	180	13	30

Lat., 38° 56′+1,043.48; long., 87° 30′+4,026.64. Elevation, 438.17.

B. M. No. 38.—A 2-inch galvanized-iron pipe on L. B., about 66.8 miles below Terre Haute; 1 mile below Shaws Landing; 1 mile above Longtown Landing Ferry, about 400 feet from river on sand knoll on land of M. E. Praether; about 200 feet SW. of barn of H. McCarty, renter, and about 3 feet N. of E. and W. fence to river.

	°	′	″
To gable of barn	210	12	30
To gable of school	348	45	00
To cupola of school	348	46	00
To gable of house	15	10	00

Lat., 38° 54′+3,140.04; long., 87° 30′+4,502.05. Elevation, 431.57.

B. M. No. 39.—A 2-inch galvanized-iron pipe on L. B., about 68.5 miles below Terre Haute; about 1 mile below Longtown Landing; about 0.25 mile from river on land of A. Black; half way between house and barns of H. Black, renter; 3 feet W. of N. and S. fence.

	°	′	″
To gable of house	232	41	00
To gable of house	233	04	30
To gable of barn	338	31	30
To upstream edge of upstream chimney	274	42	00

Lat., 38° 53′+2,543.02; long., 87° 31′+3,385.34. Elevation, 428.36.

B. M. No. 40.—A 2-inch galvanized-iron pipe on L. B., about 72.5 miles below Terre Haute; about 4.8 miles above Russellville; about 0.25 mile from top of river bank along E. and W. gravel road; about 5 feet to center line of gravel road at junction with side lane running N. to gravel bar; on land of George Price, about 800 feet from river bank.

	°	′	″
To gable of house	295	10	30
To upstream edge of chimney	294	55	00
To downstream edge of chimney	294	58	30

Lat., 38° 52′+245.98; long., 87° 32′+1,424.58. Elevation, 423.46.

B. M. No. 41.—A 2-inch galvanized-iron pipe on L. B., about 74.5 miles below Terre Haute; about 2.5 miles above Russellville; about 400 feet from top of bank on land of C. A. Beard; on knoll about 25 feet S. of residence of E. E. Brown, renter.

	°	′	″
To gable of barn on R. B	30	43	00
To gable of orange house	224	11	00
To upstream edge of chimney	223	54	00
To gable of barn	225	12	00

Lat., 38° 51′+2,031.69; long., 87° 31′+4,077.76. Elevation, 430.04.

B. M. No. 42.—A 2-inch galvanized-iron pipe on R. B., about 76 miles below Terre Haute; about 1 mile above Russellville, about 300 feet from top of bank on top of levee; on land of Mr. Bugg, tenant; about 0.5 mile below shack of Joe Stanley, outside of levee; iron bridge on public road directly west about 0.5 mile; about 500 feet below mouth of Busseron Creek, on opposite bank.

	°	′	″
To river edge of chimney	06	04	30
To gable of house	28	27	30
To gable of barn	51	34	00
To downstream edge of chimney	80	01	00

Lat., 38° 50′+248.56; long., 87° 31′+2,952.85. Elevation, 432.76.

B. M. No. 43.—A 2-inch galvanized-iron pipe on R. B., about 77.2 miles below Terre Haute; SW. corner of Russellville; on road leading W. from ferry landing; about 800 feet from river: about 15 feet N. of hedge along road; 20 feet S. of junction of N. street and E. and W. road.

	°	′	″
To church spire	177	14	30
To cupola of school	163	40	00
To church spire	171	23	00

Lat., 38° 48′+6,023.38; long., 87° 31′+4,256.64. Elevation, 426.39.

B. M. No. 44.—A 2-inch galvanized-iron pipe on R. B., about 78.5 miles below Terre Haute; about 1.25 miles below Russellville; about 75 feet from top of

river bank on top of levee; on land of C. N. Vennard; 4-foot stump on bank of river; house of Vennard on gravel road, about 0.25 mile W. of B. M.

	°	′	″
To cupola of church	70	03	30
To downstream edge of chimney	70	09	30
To gable of barn	89	15	00
To downstream edge of chimney	88	55	00

Lat., 38° 48′+941.99; long., 87° 30′+4,356.25. Elevation, 431.77.

B. M. No. 45.—A 2-inch galvanized-iron pipe on R. B., about 80 miles below Terre Haute; about 3 miles below Russellville; about one-eighth mile from river (up levee) on top levee; on land of A. B. Cunningham; about 35 feet above wire fence across levee; about 0.25 mile below house of G. L. Lemmons, renter, near levee.

	°	′	″
To cupola of barn	35	01	00
To river edge of chimney	39	23	00
To windmill	52	37	30
To gable of barn	54	43	30

Lat., 38° 47′+968.46; long., 87° 30′+1,320.64. Elevation, 430.97.

B. M. No. 46.—A 2-inch iron pipe on R. B., about 81.75 miles below Terre Haute; 8 miles above Vincennes, on land of Hines Walthon, on top of levee; about 100 feet from river; about 0.25 mile above large red barn with cupola; Alex Lago, owner, and about 500 feet from tenant house.

	°	′	″
To cupola of barn	47	20	30
To upstream edge of chimney	102	41	30
To upstream edge of chimney	102	57	00
To gable of house	154	05	00

Lat., 38° 46′+1,790.99; long., 87° 30′+4,429.64. Elevation, 431.30.

B. M. No. 47.—A 2-inch galvanized-iron pipe on R. B., about 84 miles below Terre Haute; about 6 miles above Vincennes, on top of levee; about 150 feet from river bank; about 135 feet below house of William Weitz, owner.

	°	′	″
To river edge of chimney	23	45	00
To cupola on school	66	48	00
To upstream edge of chimney	75	10	00
To upstream edge of chimney	117	05	00

Lat., 38° 45′+950.03; long., 87° 30′+1,121.45. Elevation, 429.33.

B. M. No. 48.—A 2-inch galvanized-iron pipe on R. B., about 86 miles below Terre Haute; 3.5 miles above Vincennes; 200 feet from river on levee at point where old State road crosses levee; on land of E. W. Hadden.

	°	′	″
To gable of barn	78	07	00
To gable of school	85	01	00
To gable of barn	100	52	00
To cupola of school	165	28	00

Lat., 38° 43′+3,600.58; long., 87° 30′+2,988.91. Elevation, 427.57.

B. M. No. 49.—A 2-inch galvanized-iron pipe on R. B., about 89 miles below Terre Haute; 1 mile above Vincennes; 3,000 feet above B. & O. R. R. bridge; at side of wagon road; on top of levee on land of Robeson Bros.

	°	′	″
To gable of house	177	55	00
To gable of barn	184	26	00
To upstream edge of chimney	297	20	30
To gable of house	299	34	30

Lat., 38° 41′+3,818.49; long., 87° 31′+1,939.10. Elevation, 425.77.

B. M. No. 50.—A 2-inch galvanized-iron pipe on L. B., about 90.5 miles below Terre Haute; 0.5 mile below Vincennes; at side of road; on top of levee; 125 feet from river bank.

	°	′	″
To church spire	251	27	30
To cross on church	257	56	30
To church spire	259	49	00
To monument in cemetery	325	31	30

Lat., 38° 40′+3,815.20; long., 87° 32′+2,204.08. Elevation, 424.62.

B. M. No. 51.—A 2-inch galvanized-iron pipe on L. B., about 92.2 miles below Terre Haute; 2.2 miles below Vincennes on top of levee and about 200 feet from house of Mary E. Kinnaham.

	°	′	″
To gable of house	325	59	30
To gable of barn	337	42	00
To gable of barn	00	08	00

Lat., 38° 40′+2,186.97; long., 87° 34′+1,372.69. Elevation, 423.76.

B. M. No. 52.—A 2-inch galvanized-iron pipe on L. B., about 93.7 miles below Terre Haute; 3.7 miles below Vincennes and 200 feet from river bank on top of levee; 225 feet from house on land belonging to Isaac Henderson.

	°	′	″
To lightning rod on barn	315	34	30
To gable of barn	40	11	00
To chimney	43	12	30

Lat., 38° 39′+5,206.97; long., 87° 35′+3,439.24. Elevation. 422.07.

B. M. No. 53.—A 2-inch galvanized-iron pipe on L. B., about 95.2 miles below Terre Haute; 200 feet from river bank on top of levee at junction of two levees on property of Ed. Anderson.

	°	′	″
To gable of barn	16	18	00
To gable of house	36	05	00
To gable of barn	78	10	00
To gable of barn	289	27	00

Lat., 38° 38′+3,455.19; long., 87° 36′+1,319.69. Elevation, 420.45.

B. M. No. 54.—A 2-inch galvanized-iron pipe on L. B., about 97 miles below Terre Haute and 7 miles below Vincennes; about 2.5 miles above Big Four Bridge; about 400 feet from river on levee; at side of road about 20 feet from junction of two levees; and about 500 feet from red house on land of William Brevoort.

	°	′	″
To gable of barn	334	59	00
To gable of house	349	36	30
To chimney, edge opposite river	32	45	30
To gable of house	280	28	00

Lat., 38° 37′+3,446.23; long., 87° 36′+4,058.09. Elevation. 418.81.

B. M. No. 55.—A 2-inch galvanized-iron pipe on L. B., about 101 miles below Terre Haute; 11 miles below Vincennes and about 2 miles above St. Francisville; about 1.6 miles below Big Four Bridge; about 500 feet from river on gravel road and about 800 feet from two-story white house, William Brevoort owner and Otto Bledsoe renter.

	°	′	″
To gable of barn	220	43	30
To gable of barn	221	34	00
To gable of barn	227	12	00
To gable of house	258	47	00

Lat., 38° 35 ⊦2,369.59; long., 87° 36′+2,519.31. Elevation, 406.58.

B. M. No. 56.—A 2-inch galvanized-iron pipe on L. B., about 103 miles below Terre Haute; across river from St. Francisville, on gravel road leading to ferry; about 150 feet from ferry landing; about 150 feet above white house.

	°	′	″
To flagpole on school, at roof	84	46	30
To church spire	93	46	30
To gable of barn	120	39	00
To downstream edge of chimney	92	48	00

Lat., 38° 35′+3,748.61; long., 87° 38′+1.150.25. Elevation, 406.87.

B. M. No. 57.—A 2-inch galvanized-iron pipe on L. B., about 105 miles below Terre Haute; 2 miles below St. Francisville; about 0.5 mile from river bank and about 50 feet from house; in garden of Charles Rose. renter—William Brevoort, owner; about 0.7 mile below Beal church and school.

	°	′	″
To gable of house	319	56	30
To river edge of chimney	320	01	30
To gable of barn	37	55	00
To gable of barn	249	18	00

Lat., 38° 33′+5,507.42; long., 87° 38′+2.200.82. Elevation, 407.41.

B. M. No. 58.—A 2-inch iron pipe on L. B., about 106 miles below Terre Haute; 3 miles below St. Francisville; about 100 feet from river at side and end of gravel road; in front of two-story white house, W. T. Raney, renter—J. M. Newton, owner.

	°	′	″
To gable of house	270	33	30
To gable of barn	267	04	30
To gable of barn, joint of cornice	10	33	00
To gable of house	268	41	00

Lat., 38° 33′+1.269.67; long., 87° 39′+1,098.75. Elevation, 406.35.

B. M. No. 59.—A 2-inch galvanized-iron pipe on L. B., about 108 miles below Terre Haute; about 5 miles below St. Francisville; about 800 feet from river and about 100 feet from white house; in garden of William Carter, renter—Capt. C. L. Lewis, owner; about 25 feet from private road running to river.

	°	′	″
To gable of house	225	53	00
To upstream edge of chimney	226	05	30
To base line stake No. 223	201	53	30

Lat., 38° 32′+296.46; long., 87° 39′+1,662.22. Elevation, 403.33.

B. M. No. 60.—A 2-inch galvanized-iron pipe on L. B., about 110 miles below Terre Haute; about 3 miles above Little Rock; opposite Catfish Bend; about 1 mile back from river on N. and S. gravel road, just below wagon bridge over pond; about 250 feet from oil well and 200 feet from house, Ward Fry, owner.

	°	′	″
To gable of house	357	42	30
To gable of house	358	01	30
To river-edge chimney	357	26	30
To gable of barn	230	39	00

Lat., 38° 30′+498.20; long., 87° 37′+3860.33. No elevation.

B. M. No. 61.—A 2-inch galvanized-iron pipe on L. B., about 111.2 miles below Terre Haute; about 0.75 mile above Little Rock, on sand ridge; at side of N. and S. wagon road; about 700 feet from river; about 600 feet from log house; and about 120 feet from house, David Warth, renter, Mary Valentine, owner.

	°	′	″
To river edge of chimney	06	38	00
To river edge of chimney	41	54	00
To gable of house	196	32	00

Lat., 38° 29′+5,893.66: long., 87° 40′+7925. Elevation, 416.14.

B. M. No. 62.—A 2-inch galvanized-iron pipe on L. B., about 114.1 miles below Terre Haute; about 9.1 miles above Mount Carmel; about 2.1 miles above Buchanan's ferry; about 500 feet from river and 80 feet from barn; 225 feet from two-story white house on land of William Stickler.

	°	′	″
To gable of barn	65	17	00
To gable of house	12	08	00
To gable of barn	337	27	30

Lat., 38° 28′+5,255.38; long., 87° 42′+386.20. Elevation, 404.50.

B. M. No. 10 (1903 survey).—Pipe and cap on L. B., about 112.8 miles below Terre Haute; at Little Rock in turn in lane where road leaves the river; about 20 paces E. of public scales; W. end of corn crib; 12 meters E. of mail box of Edwin Self standing at angle of road.

	°	′	″
To school house, top of roof	266	49	00
To gable of barn	307	21	00
To gable of house	350	05	30
To gable of barn	37	11	00

Lat., 38° 29′+4,121.28; long., 87° 40′+3,481.18. Elevation, 403.49.

B. M. No. 63.—A 2-inch galvanized iron pipe on L. B., about 115.2 miles below Terre Haute; about 1 mile above Buchanan's ferry; about 50 feet from river at side of river road; about 80 feet from two-story white house on land of J. W. Price, and 6 feet from 22-inch elm tree.

	°	′	″
To gable of house	320	44	30
To church cupola	322	52	00
To base-line stake No. 239	290	50	00

Lat., 38° 28′+4,236.37; long., 87° 43′+1,670.77. Elevation, 405.80.

B. M. No. 64.—A 2-inch galvanized iron pipe on L. B., about 116.2 miles below Terre Haute; about 7 miles above Mount Carmel; about 650 feet from river in barn lot about 25 feet from red barn and at end of road to Buchanan's ferry; 125 feet from corncrib with windmill on opposite side, Robert Mayhan, owner.

	°	′	″
To river edge of chimney	260	25	00
To gable of church	283	20	30
To cupola of church	283	08	30
To gable of house	302	09	30

Lat., 38° 28′+3,326.22; long., 87° 44′+1,693.51. Elevation, 403.45.

P. B. M. No. 29.—Concrete slab and iron pipe on L. B., about 119.1 miles below Terre Haute and about 4 miles above Mount Carmel; on land of James Carson, Reuben Reed, tenant; in front of and directly in line with S. side of a small subtenant house, which stands on high ground; about 15 feet W. of SW. corner of house and about 15 feet from center line of road which runs along river; about 1.7 miles above Grand Rapids Lock.

	°	′	″
To gable of barn	272	07	00
To base-line stake No. 245	115	04	30

Lat., 38° 27′+1,970.48; long., 87° 44′+718.72. Elevation, 405.50.

B. M. No. 65.—A cross with the letters "U. S. Eng. B. M. 65"; on the top of lower end of the land side of masonry of the Grand Rapids Lock. It is 1 foot south and 1 foot east of the northeast corner of the wide part of lock wall and 15 feet east of inner side of wall of lock chamber. To center of gate capstan 44° 27′ 00″, 15.2 feet.

	°	′	″
To gable of red barn	109	24	10
To gable of house	304	03	30
To top of gauge post	200	39	30
To gable of lock-master's cottage	232	58	10

Lat., 38° 26′+508.4; long., 87° 44′+1,910. Elevation, 397.15.

B. M. No. 66.—A 2-inch galvanized iron pipe on L. B., about 122 2 miles below Terre Haute; across river from Mount Carmel; about 700 feet below Fifth Street ferry; on L. B. White River; about 25 feet from same; at point where it empties into Wabash; at side of wagon road; 15 feet from 36-inch blazed elm, azimuth 32°.

	°	′	″
To gable of barn	257	45	30
To gable of house	84	21	00
To gable of house	84	19	00
To gable of house	134	10	00

Lat., 38° 24′+4,933.61; long., 87° 44′+2,270.72. Elevation, 392.22.

B. M. No. 67.—A 2-inch galvanized iron pipe on L. B., about 124 miles below Terre Haute; about 1.9 miles below mouth of White River and about 0.2 mile below Southern R. R. bridge at Mount Carmel; about 1,000 feet from river on wagon road leading to river; at a point opposite Patoka Island; on upstream side of land of Sylvester Greegs.

	°	′	″
To gable of barn	284	58	30
To gable of barn	108	32	00
To gable of shed	114	14	30

Lat., 38° 23′+3.408.75; long., 87° 45′+166.45. Elevation, 393.01.

B. M. No. 68.—A 2-inch galvanized-iron pipe on L. B., about 125 2 miles below Terre Haute; about 2 miles below Mount Carmel; about 0 3 mile from river on wagon road; road runs to river and Charity Church is in grove on road about 150 feet from river; B. M. is 400 feet from Burnett School, also on road; pecan grove on left, Abner Depty, owner.

	°	′	″
To gable of shed	350	18	00
To gable of house, end of roof	182	50	30
To gable of barn	359	40	30

Lat., 38° 22′+4,508.89; long., 87° 45′+3.258.67. Elevation, 394.94.

B. M. No. 69.—A 2-inch galvanized iron pipe on L. B., about 126 miles below Terre Haute; about 2.8 miles below Mount Carmel; about 0.4 mile above new

Big Four bridge; about 150 feet from river between house and barn; about 125 feet from barn, Herbert Walden, owner, ditch between B. M. and house; B. M. about 35 feet from top of bank.

	°	′	″
To gable of house	212	18	30
To gable of barn	2	13	00

Lat., 38° 22′+359.36; long., 87° 46′+3,888.10. Elevation, 394.18.

B. M. No. 70.—A point in center of 1.75-inch square on Big Four bridge pier, about 126.4 miles below Terre Haute; 3.2 miles below Mount Carmel; B. M. is on left-end pier of bridge on upstream side, 4.6 feet from river edge of pier and 3.1 feet from upstream edge of pier.

	°	′	″
To gable of barn	343	02	00
To middle depot chimney	344	50	00
To railroad bridge (first vertical on right side of)	218	42	00

Lat., 38° 21′+5,710.42; long., 87° 47′+1,134.63. Elevation, 401.42.

B. M. No. 71.—A 2-inch galvanized iron pipe on L. B., about 128 miles below Terre Haute; about 4.8 miles below Mount Carmel; about 1.5 miles below Big Four bridge; about 0.4 mile above Coffee Island; about 200 feet from river at side of private road running below white house and to river. B. M. is 75 feet from house and about 125 feet from barn above house.

	°	′	″
To gable of house	205	38	30
To gable of barn	168	06	30

Lat., 38° 21′+2,199.22; long., 87°48′+2,530.60. Elevation, 392.14.

B. M. No. 72.—A 2-inch galvanized iron pipe on L. B., about 129.3 miles below Terre Haute; about 5.9 miles below Mount Carmel; about 400 feet above ferry; about 100 feet from river at side of wagon road along river, opposite small town of Rochester, Ill.; about 300 feet above road leading away from river; and about 500 feet from large granary.

	°	′	″
To gable of shed	253	09	00
To gable of barn	255	44	00
To downstream edge of chimney	257	19	30
To gable of house	256	53	30

Lat., 38° 20′+4,167.73; long., 87° 49′+1,380.38. Elevation, 393.02.

B. M. No. 73.—A 2-inch galvanized iron pipe on L. B., about 130.2 miles below Terre Haute; about 1.5 miles below Coffee Island, and about 3 miles above Crowleyville, Ind.; about 800 feet from river at cross roads; about 125 feet from house where George McClellen lives; about 60 feet from big red barn and about 40 feet from granary, both on his farm; about 500 feet from Burn's schoolhouse on E. and W. road.

	°	′	″
To gable of barn	204	01	30
To gable of shed	267	00	30
To upstream edge of chimney	268	36	30
To cupola on Burn's school	275	53	00

Lat., 38° 19′+4,688.16; long., 87° 49′+2,051.68. Elevation, 393.42.

B. M. No. 74.—A 2-inch galvanized-iron pipe on L. B., about 131.5 miles below Terre Haute; 2.7 miles below Coffee Island; about 1.75 miles above Crowleyville; about 500 feet from river on top of levee running parallel to river and between road and house; about 50 feet from house; John Howard, renter, and George Wilbern, owner.

	°	′	″
To gable of barn	218	42	00
To gable of log house	320	09	30
To gable of house	343	52	00

Lat., 38° 18′+4,217.47; long., 87° 49′+3,005.02. Elevation, 392.71.

P. B. M. No. 32.—A concrete slab and iron pipe and cap on L. B., about 132.25 miles below Terre Haute; about 3 miles below Rochester ferry; about 1 mile above Crowleyville; 30 feet from 40-inch hickory on top of river bank; 3 feet

inside fence of NW. corner of yard of house where Jordan Garrett lives on land of Wesley Harmon.

	°	′	″
To gable of barn	194	30	30
To gable of house	237	04	30
To gable of barn	207	46	00

Lat., 38° 17′+5,628.05; long., 87° 49′+3,602.24. Elevation, 390.12.

B. M. No. 75.—A 2-inch galvanized-iron pipe on L. B., about 133.5 miles below Terre Haute; in town of Crowleyville; about 250 feet from river in pasture of Jim Cuningham; about 2 feet from E. and W. fence and about 200 feet from downstream edge of large corncrib; about 250 feet NE. of house where Alva Burget lives; 150 feet from river road.

	°	′	″
To gable of house	225	51	30
To gable of barn	243	53	30
To gable of house	253	03	30

Lat., 38° 16′+5,350.13; long., 87° 50′+902.40. Elevation, 390.15.

B. M. No. 76.—A 2-inch galvanized-iron pipe on L. B., about 134.5 miles below Terre Haute; about 200 feet below Jimtown; about 200 feet from river on river side of river road; about 175 feet below shed with red tin roof; about 175 feet below small house on river side of road; in timbered slough, 49 feet above 36-inch cottonwood on river edge of road; cottonwood blazed azimuth 270°; an 18-inch locust tree is across road from cottonwood and 51 feet from B. M.; B. M. is 9 feet from J. Blair's mail box on land of Jim Cuningham.

	°	′	″
To gable of house	116	06	00
To nail in blaze on locust	61	12	30

Lat., 38° 16′+2,321.17; long., 87° 51′+1,344.98. Elevation, 389.44.

B. M. No. 77.—A 2-inch galvanized iron pipe on L. B., about 135.5 miles below Terre Haute; about 1 mile below Jimtown; about 600 feet from river at junction of private river road and road running W. about 0.25 mile N. of house and about 800 feet below white house, both on river road; B. M. is on E. and W. road, which is dividing line between land of Aaron Robb on the N. and Preston Robb on the south.

	°	′	″
To gable of house	92	47	30
To downstream edge of chimney	204	22	30
To upstream edge of chimney	204	29	30
To gable of house	205	01	00

Lat., 38° 17′ + 340.68; long., 37° 52′ + 624.73. Elevation, 388.85.

B. M. No. 78.—A 2-inch galvanized iron pipe on L. B., about 140 miles below Terre Haute; about 2 miles below McCrearys Bluff; about 250 feet from river in NE. corner of field; two roads, one running E. and W. and the other N. and S., about 900 feet W. of Pfeiffer school; on N. side of road; about 200 feet W. of red house and about 500 feet NE. of another red house in same field, on land of M. A. Kelly.

	°	′	″
To upstream edge of chimney	264	44	00
To cupola of school	266	15	30
To gable of house	276	43	00
To gable of house	45	51	30

Lat., 38° 17′ + 389.90; long., 87° 53′ + 1,169.77. Elevation, 384.98.

B. M. No. 79.—A 2-inch galvanized iron pipe on L. B., about 141.2 miles below Terre Haute; about 3 miles below McCrearys Bluff; about 3 miles above Peankashaw Bend; about 250 feet from river at side of river road and 2 feet from fence; at NE. corner of barn lot; in field about 90 feet from NE. corner of barn on mound; about 250 feet from house where Compton lives on land of William Styles.

	°	′	″
To gable of shed	7	49	00
To gable of house, joint in cornice	15	08	00

Lat., 38° 16′ + 1,523.36; long., 87° 54′ + 311.70. Elevation, 383.96.

B. M. No. 80.—A 2-inch galvanized iron pipe on L. B., about 142 miles below Terre Haute; about 4 miles below McCrearys Bluff; about 2 miles above Peankashaw Bend; about 120 feet from river on top of levee; about 50 feet from SE. corner of barn; about 150 feet S. of house, Charles Freeman, owner.

	°	′	″
To gable of barn	32	33	30
To middle chimney	32	53	30
To gable of house	33	08	30
To gable of barn	34	28	30

Lat., 38° 16′+1,898.22; long., 87° 55′+809.52. Elevation, 389.69.

B. M. No. 81.—A 2-inch galvanized-iron pipe on L. B., about 143 miles below Terre Haute; about 5 miles below McCrearys Bluff; at Peankashaw Bend; about 600 feet from river; about 2 feet from barnyard fence; about 75 feet from corner of big red barn on mound; about 30 feet from house of C. L. Gilmore, renter; James Cooper, owner.

	°	′	″
To gable of barn	53	27	00
To gable of house	115	10	30
To knot hole 2 feet below gable of house	115	08	00

Lat., 38° 17′+417.51; long., 87° 55′+590.73. Elevation, 384.32.

B. M. No. 82.—A 2-inch galvanized-iron pipe on L. B., about 146 miles below Terre Haute; about 0.25 mile below Siegerts Island; about 6.5 miles above Grayville; about 100 feet from river in open field on side of mound where barn sets; B. M. is about 15 feet from barn and 250 feet from house; William Majors, renter; Herman Siegert, owner.

	°	′	″
To chimney edge away from river	215	08	00
To gable of house	255	50	00
To chimney edge toward river	256	26	30

Lat., 38° 17′+568.09; long., 87° 56′+564.12. Elevation, 381.37.

B. M. No. 83.—A 2-inch galvanized-iron pipe on L. B., about 147.8 miles below Terre Haute; about 2.2 miles below Siegerts Island; about 4.6 miles above Grayville; about 700 feet from river; 4 feet from fence running along the downstream edge of large grove; about 900 feet from vacant log house on land of Herman Seigert.

	°	′	″
To gable of log house	349	46	00
To gable of log house	351	11	30

Lat., 38° 16′+890.29; long., 87° 56′+2,306.48. Elevation, 381.95.

B. M. No. 84.—A 2-inch galvanized-iron pipe on L. B., about 148.7 miles below Terre Haute; about 0.5 mile above Johnsons Ferry and about 3.7 miles above Grayville; about 200 feet from river on the Virgil Boseman estate; about 60 feet from SE. corner of house with row of 20-inch maple trees in front; B. M. is 8 feet from double maple, the last in row on downstream end; 15.8 feet from edge of concrete foundation corncrib; about 130 feet from barn; B. M. is about 400 feet below B. M. No. 23 of 1903 survey.

	°	′	″
To gable of house	264	43	00
To gable of house	265	35	30
To middle of phone pole, 4 feet above ground	344	07	00

Lat., 38° 15′+1,781.70; long., 87° 56′+4,060.51. Elevation, 383.76.

B. M. No. 85.—A 2-inch galvanized-iron pipe on L. B., about 150.4 miles below Terre Haute; about 1.3 miles below Johnson's ferry; about 0.3 mile below ditch with bridge crossing it 30 feet from river; in field, 5 feet from SW. corner of garden; about 10 feet from SW. corner of chicken house; about 150 feet from SW. corner of old red barn and about 100 feet from house where Otto Burnett lives; river road running in front of house on land of Cake & Gonoman; B. M. is about 0.5 mile above Kingdom Island; 2 miles above Grayville, Ill.

	°	′	″
To gable of barn	93	47	00
To gable of house	94	30	00
To upstream edge of chimney	94	29	30

Lat., 38° 14′+1,416.16; long., 87° 57′+4,181.59. Elevation, 380.63.

B. M. No. 86.—A 2-inch galvanized-iron pipe on L. B., about 151.2 miles below Terre Haute; opposite Kingdom Island; about 1 mile above I. C. R. R. bridge; about 200 feet from river at side of wagon road running to Grayville ferry and about 1 mile back on road from ferry on land belonging to Harry Blood; about 22 feet from 10-inch blazed locust, azimuth 276°.

	°	′	″
To center line draw span, I. C. bridge	19	29	00
To center line pier of I. C. bridge	24	19	00
To gable of house	315	50	00

Lat., 38° 14′+3,951.33; long., 87° 58′+2,931.12. Elevation, 379.15.

B. M. No. 87.—A 2-inch galvanized-iron pipe on L. B., about 154.4 miles below Terre Haute; about 2 miles below Grayville; about 200 feet below I. C. R. R. bridge; about 900 feet from river at end of trestle: about 200 feet from track on downstream side; about 2 feet from fence at side of road; about 90 feet from shed; across road; about 150 feet from red barn and 400 feet from house on land of H. P. Owens.

	°	′	″
To gable of house	301	53	00
To cupola of school	307	01	00
To gable of house	309	33	30
To gable of barn	345	41	30

Lat., 38° 13′+4,309.44; long., 87° 58′+3,688.86. Elevation, 378.76.

B. M. No. 88.—A 2-inch galvanized-iron pipe on L. B., about 155.8 miles below Terre Haute; about 1.4 miles below I. C. R. R. bridge below Grayville; on river side of private farm road running along main high bank; about 450 feet from river; about 25 feet from vacant house; about 35 feet from barn on land of Mr. Griffen.

	°	′	″
To nail in 30-inch blazed elm, 125 feet	42	05	30
To nail in 20-inch blazed elm, 200 feet	64	13	00
To nail in 30-inch blazed elm, 16 feet	132	08	00

Lat., 38° 12′+4,431.04; long., 87° 58′+3,852.91. Elevation, 377.84.

B. M. No. 89.—A 2-inch galvanized-iron pipe on L. B., about 156.6 miles below Terre Haute; about 4.2 miles below Grayville; 2.2 miles below I. C. R. R. bridge, on land of Henry Mann; about 25 feet from tenant house in corner of garden; about 350 feet from river; about 30 feet from private farm road running along river bank and turning away from river at this point.

	°	′	″
To end of barn roof	269	13	30
To base line stake No. 326	146	46	00

Lat., 38° 12′+529.38; long., 87° 58′+2,315.54. Elevation, 377.31.

B. M. No. 90.—A 2-inch galvanized-iron pipe on L. B., about 158.5 miles below Terre Haute; about 6.3 miles below Grayville; about 4.3 miles below I. C. R. R. bridge on land of John Whitehead; about 0.4 mile from river in corner of garden, about 2 feet from fence; about 10 feet from corner of chicken house; about 30 feet from corner of house; R. Brooks, renter; road in front of house makes turn and follows river.

	°	′	″
To gable of barn	193	51	00
To gable of barn	208	17	00
To gable of school	241	41	30
To cupola of church	244	17	30

Lat., 38° 11′+1,641.85; long., 87° 57′+335.75. Elevation, 381.11.

B. M. No. 91.—A 2-inch galvanized-iron pipe on L. B., about 159.4 miles below Terre Haute; about 7 miles below Grayville and about 2.8 miles above mouth of Black River; about 1.4 miles above Bald Point; about 7 miles above New Harmony; about 200 feet from river on river side of N. and S. road; about 300 feet from cross roads; at cross roads the road runs E. and on W. becomes river road; about 100 feet from white house across road where Levi Ryden lives; on land of Horace Owens. John Whitehead owns land on W. side of road.

	°	′	″
To gable of house	136	46	00
To gable of barn	154	00	30
To gable of house	185	01	30
To monument in cemetery	188	02	30

Lat., 38° 10′+4,204.63; long., 87° 56′+1,280.42. Elevation, 378.05.

B. M. No. 92.—A 2-inch galvanized-iron pipe on L. B., about 161.8 miles below Terre Haute, in New Baltimore; about 4.2 miles above New Harmony; about 600 feet from river in corner of field; about 2 feet from corner of fence; about 20 feet from center line of N. and S. road; about 300 feet from house where Wm. Schnarr lives, azimuth about 310°; about 125 feet from house, azimuth 73°; B. M. is 15 feet from 8-inch double elm on land of James Jones. John Whitehead owns land across the N. and S. road.

	°	′	″
To gable of barn	177	04	30
To upstream edge of chimney	178	33	30
To church spire	197	47	00
To donwstream edge of chimney	25	04	30

Lat., 38° 10′+1,875.10; long., 87° 55′+3,338.11. Elevation, 383.06.

B. M. No. 93.—A 2-inch galvanized-iron pipe on L. B., about 163.3 miles below Terre Haute; about 1.1 miles below mouth of Black River; about 0.9 mile above Juno Island; about 2.7 miles above New Harmony; about 175 feet from river on N. side of orchard farm of Fred Caede; about 250 feet above house and 2 feet from fence; about 150 feet from river road along top of bank; about 100 feet from 18-inch gum in pasture, azimuth 142° 59′ 00″.

	°	′	″
To gable of barn	148	26	00
To gable of barn	148	58	00
To gable of house	217	48	00
To cupola of school	248	29	30

Lat., 38° 09′+4,544.28; long., 87° 54′+2,802.75. Elevation, 377.55.

B. M. No. 94.—A 2-inch galvanized-iron pipe on L. B., about 164.5 miles below Terre Haute; about 1.5 miles above New Harmony; about 300 feet from river in field (NW. corner); about 3 feet from fence; about 20 feet from center line of N. and S. river road on top of second high bank; about 600 feet above house, W. T. Boyce, renter, Lichtenberger Bros., owners; about 400 feet below old house and about 50 feet S. of 10-inch locust tree on fence line.

	°	′	″
To gable of barn	278	57	30
To middle chimney	280	03	00
To gable of barn	281	25	00
To gable of barn	293	59	30

Lat., 38° 08′+4,378.40; long., 87° 55′+3.321.33. Elevation, 375.85.

"Triangle." New Harmony.—U. S. Engineer's iron pipe on L. B., about 166.1 miles below Terre Haute; in town of New Harmony, about 600 feet from river on edge of alley; 6.2 feet N. of corner of Capt. Ribeyre's red barn; pipe has been moved 23 feet N. of its original position.

	°	′	″
To gable of house	317	36	30
To downstream edge of chimney, next to roof	272	45	30

Lat., 38° 07′+4,147.85; long., 87° 56′+1,747.22. Elevation, 379.33.

B. M. No. 95.—A 2-inch galvanized-iron pipe on R. B. of New Harmony Cut-off; about 166.3 miles below Terre Haute on Ribeyre Island; about 90 feet from old river and about 300 feet from Ribeyre's private ferry, which runs across cut-off; about 20 feet from 24-inch blazed elm, azimuth 330°; 45 feet from 36-inch blazed sycamore, azimuth 233° 30′; about 45 feet from 18-inch blazed sycamore, azimuth 118°.

	°	′	″
To gable of red school	251	12	00
To gable of barn	266	59	00
To gable of house	271	24	00
To gable of house	275	21	30

Lat., 38° 07′+4,232.14; long., 87° 56′+4,315.69. Elevation, 372.09.

Triangle, Mound Hill.—A pipe set on L. B. on top of first high hill below New Harmony; about 167 miles below Terre Haute; it is 3 feet W. of fence and 27 feet N. of white oak tree; the old dam is at the foot of this hill and slightly upstream from triangulation station.

	°	′	″
To gable of barn	187	29	30
To gable of house	191	00	30
To gable of house	87	25	30
To gable of house	94	17	30

Lat., 38° 07′+1,794.82; long., 87° 56′+2,888.75. No elevation.

Triangle 4 (1902 survey).—A pipe and cap set on L. B. of river about 169 miles below Terre Haute; about 3 miles below New Harmony; about 0.5 mile below head of Turkey Island; 160 feet from top of river bank; 12 feet W. from corner of a barn; about 110 feet NE. of corner of a house where John Fischer lives; about 20 feet S. of fence corner and 50 feet E. of corncrib on Ribeyres Island.

	°	′	″
To gable of house	207	45	00
To river edge of chimney	41	14	00
To Triangle Mound Hill	244	35	30

Lat., 38° 06′+3,756.67; long., 87° 58′+2,024.92. Elevation, 372.17.

Triangle 10 (1902 survey).—An iron pipe and cap on L. B., about 171.8 miles below Terre Haute; about 5.8 miles below New Harmony on Ribeyres Island; about 400 feet from river; about 4 feet from fence; about 8 feet W. from pump house; about 15 feet S. from barn, and about 100 feet from house where Stewart lives.

	°	′	″
To gable of barn	237	39	30
To edge of shed	342	21	00

Lat., 38° 05′+4,592.77; long., 88° 00′+3,500.0. Elevation, 371.24.

Triangle 9 (1902 survey).—Iron pipe on L. B., about 173.4 miles below Terre Haute on Ribeyres Island; 100 feet below vacant house; about 40 feet from top of bank; 30 feet from center line of river road along top of bank; also road turning into corn field between house and triangle 9; Mr. Mitchell lives about 600 feet above on river road; triangle 9 is about 400 feet from river.

	°	′	″
To gable of house	73	56	00
To river edge of chimney	245	36	30

Lat., 38° 05′+1,821.80; long., 87° 59′+4,698.53. Elevation, 369.65.

B. M. No. 96.—A 2-inch galvanized-iron pipe on R. B., about 168 miles below Terre Haute; in New Harmony Cut-off; about 2 miles below New Harmony; about 0.6 mile above mouth of cut-off on Ribeyres Island; at edge of cornfield and 4 feet from top of high bank; about 40 feet above lower end of a small patch of timber; B. M. is 300 feet below falls in cut-off.

	°	′	″
To gable of barn	87	12	00
To middle of chimney	89	17	30
To gable of barn	89	36	00

Lat., 38° 6′+3,359.13; long., 87° 57′+1.241.60. Elevation, 369.38.

B. M. No. 97.—A 2-inch galvanized-iron pipe on R. B., about 175 miles below Terre Haute; about 9 miles below New Harmony; about 1.4 miles above Winklers Ferry; about 100 feet from Old River; about 0.6 mile up Old River from mouth of cut-off; at SE. corner of barn and about 4 feet from same on land of Arthur Dransfield.

	°	′	″
To gable of house	305	23	30
To gable of barn	311	59	30
To chimney, edge away from river	305	48	30
To middle chimney	343	11	00

Lat., 38° 5′+4,049.79; long., 87° 58′+769 49. Elevation, 374.67.

B. M. No. 98.—A 2-inch galvanized-iron pipe on R. B., about 176.4 miles below Terre Haute; about 10.4 miles below New Harmony; 6.6 miles above Maunie at upstream side of road leading to Winklers Ferry and about 600 feet from river; about 2 feet from fence; road forks at this point, the upstream fork runs to ferry, downstream fork to a house about 300 feet from B. M. Ed. Kimball, renter; Arthur Dransfield, owner. Lee Woods owns land on N. side of road.

	°	′	″
To gable of barn	13	56	00
To gable of ventilator	14	01	00
To gable of barn	47	33	30
To river edge of chimney	46	52	30

Lat., 38° 5′+2,198.90; long., 87° 57′+3,086.19. Elevation, 371.20.

B. M. No. 99.—A 2-inch galvanized-iron pipe on R. B., about 178 miles below Terre Haute; about 1.6 miles below Winklers Ferry; about 5 miles above

Maunie; about 400 feet from river along private road; about 2 feet from garden fence; about 200 feet from big barn and about 200 feet from house; Charles Horton, renter, and Martin Golden, owner; opposite Warwicks Ripple.

	°	′	″
To gable of barn	47	14	00
To middle chimney	48	35	00

Lat., 38° 4′+1,831.21; long., 87° 58′+271.25. Elevation, 367.13.

B. M. No. 100.—A 2-inch galvanized-iron pipe on R. B., about 179.4 miles below Terre Haute; about 1.7 miles below Mink Island; about 3.6 miles above Maunie; about 100 feet from river; about 80 feet from shed and about 100 feet below house where Roy Monday lives; on land of Charles Elliott.

	°	′	″
To gable of house, middle of ridge roll	261	52	30
To gable of house	55	31	30
To gable of barn	63	57	00
To gable of barn	64	25	00

Lat., 38° 03′+141.25; long., 87° 59′+953.27. Elevation, 366.62.

B. M. No. 101.—A 2-inch galvanized-iron pipe on R. B., about 181.3 miles below Terre Haute; about 0.5 mile below Twin Sister Island No. 2; about 1.7 miles above Maunie; 500 feet from river in corner of garden; about 12 feet from fence; along road and about 2 feet from fence between garden and yard; 150 feet SW. of barn and about 100 feet S. of house of John Anselment, renter, and Frank Sefied, owner.

	°	′	″
To gable of house	170	10	00
To base line stake No. 384	297	42	30

Lat., 38° 03′+2,325.95; long., 88° 01′+729.02. Elevation, 368.53.

B. M. No. 102.—A 2-inch galvanized-iron pipe on L. B., about 182.5 miles below Terre Haute; about 0.5 mile above Maunie; about 600 feet from river, and about 8 feet N. of the NE. corner of a big red barn on high mound; on land of John O. Aldrich.

	°	′	″
To gable of barn	136	32	30
To gable of corn crib	217	06	00
To gable of barn	236	53	30
To gable of house	278	13	00

Lat., 38° 02′+4,583.83; long., 88° 02′+279.30. Elevation, 373.06.

B. M. No. 103.—A 2-inch galvanized-iron pipe on L. B., about 183.3 miles below Terre Haute; about 0.3 mile below Maunie; 1.9 miles above Grand Chain; 2.7 miles above L. & N. bridge; about 600 feet from river on mound; about 24 feet from small red house, Levi Churchill, renter.

	°	′	″
To gable of barn	153	18	30
To gable of barn	174	25	30
To river edge chimney	174	49	30

Lat., 38° 02′+1,447.72; long., 88° 02′+10.49. Elevation, 364.08.

B. M. No. 104.—A 2-inch galvanized-iron pipe on L. B., about 185.3 miles below Terre Haute: about 2.3 miles below Maunie at head of Grand Chain; 0.8 mile above L. & N. bridge; about 100 feet from river; at intersection of river road and road running E. of river back to hills; about 6 feet below fence running along road to hills; about 300 feet above house, James Thomas renter, Enoch Allison owner.

	°	′	″
To upstream edge of chimney	282	38	30
To gable of shed	285	47	30
To gable of barn	288	12	00
To gable of house	32	29	30

Lat., 38° 01′+3,269.25; long., 88° 00′+1,671.68. Elevation, 365.27.

B. M. No. 105.—A 2-inch galvanized-iron pipe on L. B., about 186.3 miles below Terre Haute; 3.3 miles below Maunie; 0.3 mile below L. & N. bridge; about 600 feet from river; about 6 feet NE. of NW. corner of barn lot; about

100 feet NW. of barn; about 100 feet W. of house, William Good renter, E. M. Spencer owner.

	°	′	″
To gable of barn	229	51	00
To gable of house	350	08	00
To river edge of chimney	19	01	00
To B. M. No. 106	3	14	30

Lat., 38° 00′+4,734.14; long., 88° 01′+857.11. Elevation, 369.10.

B. M. No. 106.—A 2-inch galvanized-iron pipe on L. B., about 187 miles below Terre Haute; about 4 miles below Maunie; about 1 mile below L. & N. bridge; on N. side of E. and W. road running away from river; about 400 feet from river on land of Marion Oldridge; about 500 feet below tenant house; about 30 feet from double walnut tree; azimuth, 105° 30′.

	°	′	″
To gable of barn	184	12	00
To middle chimney	185	21	00
To gable of house	296	33	30
To B. M. No. 105	183	14	30

Lat., 38° 00′+1,241.80; long., 88° 01′+1,054.75. Elevation, 365.59.

B. M. No. 33 (1902 survey).—A pipe and cap set on L. B., about 187.7 miles below Terre Haute; about 1.75 miles below L. & N. bridge; in line with the upper side of a steel structure built for use as tower for supporting telephone wires crossing the river; it is 30 feet from the base of the tower toward the river.

	°	′	″
To gable of house	300	33	00
To gable of barn	301	31	00
To middle of chimney	284	07	30
To middle of chimney	284	26	30

Lat., 37° 59′+4,617.42; long., 88° 01′+623.38. Elevation, 361.16.

P. T. S. No. 27, U. S. G. S.—At Rising Sun village, 0.33 mile southeast of; under center of steel telephone tower on west side of river; iron post stamped "Prim. Trav. Sta. No. 27, 1908, Illinois." Station about 187.7 miles below Terre Haute.

	°	′	″
To B. M. No. 33, 1902	268	09	30

Lat., 37° 59′+4,572.3; long., 88° 01′+2,040.3. Elevation, 370.85.

B. M. No. 107.—A 2-inch galvanized-iron pipe on L. B., about 189.2 miles below Terre Haute; about 6.2 miles below Maunie; about 0.8 mile below Big Creek; about 1.5 miles above Little Chain cut-off; about 200 feet from river at side of road leading away from river and to two-story house with barn above house, Mrs. Schultz owner.

	°	′	″
To top of roof, upstream end	270	10	00
To top of roof, downstream end	270	55	00
To middle of chimney	270	34	00
To gable of house	269	02	00

Lat., 37° 58′+3,618.58; long., 88° 00′+2,827.71. Elevation, 361.12.

B. M. No. 108.—A 2-inch galvanized-iron pipe on L. B., about 190.6 miles below Terre Haute; about 7.6 miles below Maunie; about 2.4 miles below Big Creek; about 700 feet above Little Chain cut-off; about 130 feet from river at downstream side of road running to river; about 600 feet above tenant house on land of M. Grobert.

	°	′	″
To gable of house	225	41	30
To gable of barn	223	56	00
To gable of barn	237	17	30
To gable of house	261	05	00

Lat., 37° 57′+3,246.77; long., 88° 01′+1,985.40. Elevation, 361.01.

B. M. No. 109.—A 2-inch galvanized-iron pipe on L. B., about 191.8 miles below Terre Haute; 8.8 miles below Maunie; 0.25 mile below head of Little Chain cut-off and on island formed by cut-off and river; about 800 feet from

river; about 1 mile below dike; 1.5 miles above foot of cut-off; about 20 feet S. of house and in line with E. side of same on land of Herman Stephan.

	°	′	″
To middle of chimney	350	52	00
To gable of house	351	11	00

Lat., 37° 57′+976.27; long., 88° 01′+4,172.33. Elevation, 358.12.

B. M. No. 110.—A 2-inch galvanized-iron pipe on L. B., about 193 miles below Terre Haute; about 2.3 miles below head of Little Chain Cut-off; about 1.3 miles below Little Chain Dike; about 0.4 mile above foot of cut-off on island; about 250 feet from river; NE. of high mound with corncribs on it; about 125 feet from same; about 75 feet NW. of scales and at side of road; on land of Herman Stephan.

	°	′	″
To gable of house	171	11	00
To top of roof, E. end	171	35	00

Lat., 37° 56′+327.07; long., 88° 01′+3,128.12. Elevation, 355.08.

B. M. No. 111.—A 2-inch galvanized-iron pipe on L. B., about 194.7 miles below Terre Haute; about 1.3 miles below foot of Little Chain Cut-off; about 400 feet from Mackeys Ferry on road leading away from ferry and downstream about 33 feet from river; in corner of grove and about 4 feet from fence; 20 feet to center line of road; about 100 feet NW. of house and 10 feet from top of bank of ditch running at right angles to road; about a 24-inch tile running under the road.

	°	′	″
To gable of barn	270	29	30
To gable of house	273	25	30
To middle of chimney	269	37	00
To chimney, edge away from river	145	50	00

Lat., 37° 54′+5,260.54; long., 88° 01′+154.02. Elevation, 362.99.

B. M. No. 112.—A 2-inch galvanized-iron pipe on L. B., about 196.2 miles below Terre Haute; 2.8 miles below foot of Little Chain Cut-off; about 1.7 miles below Mackeys Ferry; about 5.3 miles above mouth of Little Wabash; about 500 feet from river; open high bank in open field and on downstream side of a row of apple trees on land of Henry Goss.

	°	′	″
To gable of house	233	31	00
To gable of house	310	35	00
To gable of barn	355	45	00
To river edge of chimney	81	45	00

Lat., 37° 53′+2,797.70; long., 88° 01′+389.15. Elevation, 363.18.

B. M. No. 113.—A 2-inch galvanized-iron pipe on L. B., about 198.1 miles below Terre Haute; about 3.6 miles below Mackeys Ferry; about 3.4 miles above mouth of Little Wabash; about 250 feet from river; about 20 feet back from second high bank; river road between B. M. and second high bank; B. M. about 3 feet W. of NW. corner of barn lot; about 75 feet NW. of barn; about 50 feet NE. of corncrib; about 200 feet from white house, R. D. Walling, renter, and Margaret Kimball, owner.

	°	′	″
To gable of barn	28	46	00
To gable of house	213	04	30
To middle chimney	229	15	30

Lat., 37° 53′+2,321.74; long., 88° 03′+1,680.32. Elevation, 365.03.

B. M. No. 114.—A 2-inch galvanized-iron pipe on L. B., about 199.2 miles below Terre Haute; 4.7 miles below Mackeys Ferry; about 2.4 miles above mouth of Little Wabash; about 800 feet from river on upstream side of road which runs to high mound with corncrib; mound is between river and B. M.; about 600 feet above B. M. is red house; about 700 feet S. of B. M. on same road; on land of Mary Sheidel.

	°	′	″
To gable of house	10	49	00
To gable of barn	142	14	30
To gable of corncrib	236	08	00
To gable of barn	256	56	00

Lat., 37° 53′+4,545.65; long., 88° 04′+2,913.09. Elevation, 354.72.

B. M. No. 115.—A 2-inch galvanized-iron pipe on L. B., about 201.5 miles below Terre Haute; opposite mouth of Little Wabash; at upstream side of road and about 10 feet from center line of road, to river; about 200 feet from river and at edge of high bank.

	°	′	″
To downstream edge of chimney	269	47	00
To gable of house	269	52	00
To gable of barn	222	08	00

Lat., 37° 53′+3,601.29; long., 88° 05′+1,858.18. Elevation, 351.16.

B. M. No. 116.—A 2-inch galvanized-iron pipe on L. B., about 202.8 miles below Terre Haute; about 1.3 miles below mouth of Little Wabash; about 1.2 miles above Raglan Island; about 700 feet from river on high mound with corncrib; at top of second high bank; about 20 feet from fence and about 70 feet from corner of corncrib; about 110 feet N. of 10-inch blazed oak, azimuth 342° 45′; P. B. M. 49, distant 110 feet, is on same mound, azimuth 343° 05′.

	°	′	″
To gable of house	231	31	00
To upstream edge of chimney	231	33	30
To upstream edge of chimney	231	48	30
To gable of barn	237	40	30

Lat., 37° 52′+5,069.54; long., 88° 04′+2,029.31. Elevation, 362.37.

B. M. No. 117.—A 2-inch galvanized-iron pipe on L. B., about 204 miles below Terre Haute; about 2.5 miles below mouth of Little Wabash; about 3,3 miles above Bonebank; about 500 feet from river on high mound on which stands a corncrib; B. M. is about 30 feet N. of the N. corner of the crib and on upstream side of driveway; about 70 feet from tenant house on land of Allan Gray.

	°	′	″
To gable of corncrib	180	15	00
To gable of barn	182	17	00
To river edge of chimney	185	19	00
To river edge of chimney	185	23	00

Lat., 37° 51′+5,131.22; long., 88° 03′+4,722.63. Elevation, 361.29.

B. M. No. 118.—A 2-inch galvanized iron pipe on L. B., about 206 miles below Terre Haute; about 4.5 miles below mouth of Little Wabash; about 1.3 miles above Bonebank; about 600 feet from river at side of road; about 5 feet from center line of road; about 600 feet down road below vacant house; about 20 feet from second high bank on land of John Hinnenkamp.

	°	′	″
To joint in gable of house (cornice)	113	51	30
To base-line stake No. 430	106	44	30

Lat., 37° 50′+5,680.39; long., 88° 02′+2,653.73. Elevation not connected.

B. M. No. 119.—A 2-inch galvanized iron pipe on L. B., about 206.9 miles below Terre Haute: 5.4 miles below mouth of Little Wabash; 0.4 mile above Bonebank; about 200 feet from river at top of second high bank; a corncrib with driveway at each end is opposite B. M. on opposite bank.

	°	′	″
To gable of house	132	55	00
To gable of barn	140	57	00
To gable of house	138	23	00
To gable of corncrib	65	05	30

Lat., 37° 50′+2,855.42; long., 88° 01′+2,903.46. Elevation, 365.90.

B. M. No. 39 (1902 survey).—Iron pipe and cap on L. B., about 208.5 miles below Terre Haute; about 1.2 miles below Bonebank between large white locust and large hackberry tree; at end of small strip of large trees 40 feet from river, opposite the upper end of Mackeys bar, which is above island of same name.

	°	′	″
To gable of house	270	10	30
To base-line stake No. 439	248	43	30

Lat., 37° 49′+1,244.32; long., 88° 02′+2,537.99. Elevation, 349.32.

B. M. No. 120.—A 2-inch galvanized iron pipe on L. B., about 209.2 miles below Terre Haute; about 0.5 mile below Mackeys Island; about 6.8 miles above mouth of Wabash; about 500 feet from river and downstream side of driveway

to corncrib; driveway has concrete retaining wall on each side; corncrib is supported by concrete foundation; B. M. is at end of driveway and about 75 feet from crib; crib is between B. M. and river on land of Mary Dare.

	°	′	″
To gable of corncrib	279	27	00
To gable of house	295	33	30
To gable of house	341	25	00
To gable of corncrib	120	42	30

Lat., 37° 49′+1,262.95; long., 88° 03′+2,863.79. Elevation, 350.89.

B. M. No. 121.—A 2-inch galvanized-iron pipe on L. B., about 209.7 miles below Terre Haute; about 1 mile below Mackeys Island; about 2.5 miles above Skidmores bar; about 6.3 miles above the mouth of the Wabash; about 100 feet from the river and 3 feet from barnyard fence; about 15 feet N. of NW. corner of barn; about 50 feet SE. of tenant house; 70 feet from P. B. M. No. 51, azimuth 119° 11′ 30″; 97 feet from 30-inch blazed pecan tree, azimuth 184° 30′; 103 feet from 30-inch blazed cottonwood, azimuth 142° 30′; on land of Edith Gheobald; about 150 feet above high-water mound.

	°	′	″
To gable of crib	298	56	00
To edge of crib	298	47	30
To middle chimney	206	50	00

Lat., 37° 49′+2,669.61; long., 88° 04′+343.55. Elevation, 350 15.

B. M. No. 122.—A 2-inch galvanized-iron pipe on L. B., about 212.4 miles below Terre Haute; about 0.2 mile below head of Skidmores bar; about 3.6 miles above mouth of Wabash; about 50 feet from river on side of mound on which house sits; river road on top of high bank; about 60 feet from house on land of Mary K. Mackey.

	°	′	″
To gable of corncrib	310	10	00
To middle chimney	320	21	30
To middle chimney	14	26	00

Lat., 37° 48′+3,746.57; long., 88° 04′+3,788.72. Elevation, 350 42.

B. M. No. 123.—A 2-inch galvanized-iron pipe on L. B., about 213 miles below Terre Haute; at Skidmores bar and about 3 miles above mouth of the Wabash; about 175 feet from river at downstream side of large corncrib raised 23 feet above ground on concrete foundation; about 22 feet from crib on land of Peter Keck.

	°	′	″
To middle chimney	217	55	30
To corner of house	217	55	00
To corner of house	217	47	30

Lat., 37° 48′+1,824.90; long., 88° 04.+1,448.61. Elevation, 346.40.

B. M. No. 124.—A 2-inch galvanized-iron pipe on L. B., about 214.3 miles below Terre Haute; about 1.3 miles below Skidmores bar; about 1.7 miles above the mouth of the Wabash; about 800 feet from river on upstream side of road running to river and turning upstream; about 800 feet from house on same road at edge of woods on land of Emery Bennett; Clay Mackey owns land on downstream side of road.

	°	′	″
To upstream edge of chimney	179	12	30
To upstream edge of chimney	338	45	30
To edge of corncrib	78	20	30

Lat., 37° 48′+2.947.59; long., 88° 03′+1,178.78. Elevation not connected.

B. M. No. 125.—A 2-inch galvanized-iron pipe on L. B., about 215.4 miles below Terre Haute; about 2.4 miles below Skidmores bar; about 0.6 mile above mouth of the Wabash; about 200 feet from river on river side of road which follows river along high bank to mouth; about 100 feet above small house in small strip of pecan trees.

	°	′	″
To edge of corncrib	309	25	00
To downstream edge of barn ventilator	343	33	30
To river edge of corncrib	117	51	30

Lat., 37° 48′+2,954.08; long., 88° 1′+4,084.31. Elevation, 346.35.

B. M. No. 126.—A 2-inch galvanized-iron pipe on Wabash Island, about 216 miles below Terre Haute; opposite the mouth of the Wabash River and about

900 feet from right fork of Ohio River; at NE. corner of crossroads; about 75 feet from NE. corner of house; about 30 feet E. of 30-inch box-elder tree and 40 feet NW. of 16-inch walnut on land of A. Walter & Co. Mason Doll owns land across road; tenant is Aaron Burleson.

	°	′	″
To gable of barn	225	02	00
To gable of house	238	42	30
To gable of barn	212	38	30

Lat., 37° 47′+3,272.24; long., 88° 1′+2,315.32. Elevation not connected.

P. B. M. No. 54.—A concrete slab and iron pipe on L. B. of Ohio River; 0.75 mile below head of Wabash Island; about 300 feet above mouth of Lost Creek; about 1,300 feet below wagon bridge across Lost Creek; on high ground about 0.25 mile back from willow line along river; 300 feet from base of hills; 50 feet S. from SE. corner of barn; 200 feet NE. from house, H. R. Slack owner and occupant. In SE. corner of garden plot, 3 feet inside fences.

	°	′	″
To iron pipe on hill	298	03	00
To base-line stake No. 452	96	31	30

Lat., 37° 46′+4,071.01; long., 88° 00′+267.20. Elevation, 376.330.

Appendix F.

United States Engineer Office,
Louisville, Ky., September 19, 1913.

From: Walter P. Stewart, junior engineer.
To: George H. Wolbrecht, assistant engineer.
Subject: Report of precise leveling, Wabash River, from Terre Haute, Ind., to Shawneetown, Ill., 1911–12.

EQUIPMENT.

Boats.—The equipment for this survey consisted of two quarter boats, one small supply boat, one gasoline launch, and three skiffs. One quarter boat was used exclusively as a sleeping boat; it accommodated, in its full capacity, 20 men. The second quarter boat contained the kitchen, dining room, and office. In the office there were four bunks for the use of the chief of party and his principal assistants.

The supply boat was used as a storehouse for ice, tools, etc.

Instruments.—Two Kern precise levels belonging to the Mississippi River Commission were borrowed for this survey. Rods, tripods, plates, and umbrellas belonging to the Mississippi River Commission were also used.

Organization.—At the beginning of the season there were quartered on the boats two complete precise-level parties of 6 men each, one base-line party of 5 men, 1 computer and steward, 1 launchman, 1 night watchman, 1 cook, and 1 waiter.

Personnel.—George H. Wolbrecht, assistant engineer, as chief of the Wabash River survey, had general charge of the party. Walter P. Stewart, junior engineer, had immediate charge and acted as precise-level observer.

Harry A. Hickman, junior engineer, had charge of the base-line party.

Julius O. Sallee, surveyor, acted as precise-level observer during part of the season.

Joseph G. Frost, surveyor, was computer and steward.

Frank A. Irick and Robert P. Donogh were precise-level recorders.

Ralph V. Buckner was base-line recorder.

The precise-level and base-line work immediately preceded that of the topographical, sounding, and boring parties. It was therefore necessary to quarter the precise-level parties and base-line parties together, and it was at first believed that this combination of two precise-level parties and one base-line party was the best possible one, it being the plan that when expedient one precise-level party would assist in the base-line work, and that the precise-level parties would move the boats whenever practicable.

This plan operated satisfactorily during the first part of the season, but later, on account of more difficult ground, the progress of the base-line party was impeded, and it could not cover sufficient distance to maintain equal progress with one precise-level party. It was therefore decided to disband one precise-level party and retain the services of the two umbrellamen and an

additional man to be employed constantly with the base-line party. This was done, and with very good results. The base-line party of eight men and the precise-level party of six men (and at times seven) made very nearly the same progress during the latter half of the work.

METHODS.

The methods in use by the Mississippi River Commission were adopted for this survey.

Between Terre Haute, Ind., and Vincennes, Ind., the precise-level line was run either on the left or right bank according to the best working conditions.

River crossings in this stretch were made with one instrument. They were all made under good air conditions and with equal back and fore sights, three sets of readings being taken in each case.

Below Vincennes the line was run on the left bank, one side-line crossing being made at Maunie, Ill.

Bench marks.—The standard bench mark established was a concrete slab surmounted by an iron pipe. The slab is 16 by 16 by 4 inches, and has a copper bolt imbedded in its center. It was set about 3 feet below the surface of the ground. The pipe is 4 inches in diameter and 4 feet long and has an iron cap bolted to the top. The center of this cap was placed directly above the bolt in the slab. Readings were taken on copper bolt and on center of cap on pipe. These bench marks were established at an average distance apart of 4 river miles.

Other precise bench marks were established upon bridges and buildings whenever it was thought advisable to do so.

Connection was made with all bench marks of permanent character established by the survey of 1903 by the United States Engineer Office, Louisville, Ky., and with those established by the United States Geological Survey when it was possible to do so without using too much time for that particular purpose.

All elevations determined by this survey have been referred to the United States Coast and Geodetic bench mark—P. B. M. "A" 3—which is on the courthouse steps at Vincennes, Ind. The elevation of P. B. M. "A" 3 is 132.3163 meters, as adjusted in 1907 by the U. S. C. & G. S.

The elevations from Terre Haute, Ind., to Vincennes, Ind., were in the field tabulation referred to the U. S. G. S. B. M. at the post office, Terre Haute, Ind., but in the final tabulation were corrected to refer to the elevation of P. B. M. "A" 3.

DESCRIPTION.

The work started at Terre Haute, Ind., on July 18, 1911, and on July 28 the first move was made to a point about 10 miles below Terre Haute. During the early part of the season the greatest difficulty encountered was moving the boats. Frequently it was necessary to move them in two sections. Even then a good deal of trouble was experienced, due to the very low stage of the river at the time. The services of all the men in the party were required at times to assist in moving. On several occasions when the boats were grounded the only way possible to free them was to use the Spanish windlass, other methods having first proved fruitless.

The launch (12 horsepower) which towed the boats was well suited for this purpose, but of course did not have sufficient power to be of much use when the boats were stuck.

The longest delay in moving occurred in the old river just below the head of Ribeyres Island. The boats were stranded at that point more than 24 hours. The Spanish windlass was used separately upon all three boats with final success. In spite of the bad conditions met with, no serious damage was suffered by any of the boats.

On August 30 one precise-level observer, together with recorder and two rodmen, were assigned to low-water discharge work and left the party. They returned on September 17.

On October 6 one precise-level observer, together with two precise-level rodmen, were furloughed, the remaining precise-level work being done by one party.

On November 24 George H. Wolbrecht, assistant engineer, chief of the survey, joined the party at the mouth of the Wabash River. River crossings were made the following week at the mouth of the Wabash River and at Shawnee-

town, Ill., Mr. Wolbrecht using one of the instruments. The precise-level party was quartered at a hotel in Shawneetown for a couple of days.

The boats were towed from the mouth of the river to Maunie, Ill., in one day by the gasoline boat, *The Winner*, and the precise-level work ended at Maunie, Ill., on December 8.

The weather conditions throughout were favorable, except that during cold weather in November and December trouble was experienced in starting the launch on account of freezing. The progress of the work was hindered but little by sickness.

RESULTS.

The discrepancies between the elevations determined by this survey and those of the survey of 1903, determined by ordinary levels, varied considerably. They are comparatively small except at New Harmony, Ind., where differences of 1.6 feet and 2.9 feet, respectively, were found. Below New Harmony the smallest discrepancy was 2.3 feet; the largest 3 feet.

The elevations of the United States Geological Survey bench marks at Terre Haute, Ind., were 0.45 foot lower than those obtained by this survey. The same difference was found at Shawneetown, Ill., with the elevation of P. B. M. "Riverside." Other Geological elevations agreed more closely, with the exception of that at Grand Rapids Lock. The position of the bench mark there was uncertain.

SUMMARY OF RESULTS.

Total number of days, 144.
Number of party field days, 110.
Determining constants, 2½ party field days.
Sundays and holidays, 28½ days.
Rain, snow, and wind, 5½ days.
Towing, 17 days (total time).
River mileage, 226 miles.
Main line, 196.6 miles.
Side line, 25.5 miles.
Total, 221.1 miles.
River crossings, 8 with 1 instrument (3 of these on bridges); 3 with 2 instruments.
Number of P. B. M's. established (concrete slab and pipe), 54.
Number of P. B. M's. established (others), 11
Number of P. B. M's connected with (U. S. E.), (U. S. G. S.), and (U. S. C. & G. S.), 35.
Rate per day per season, 1.5 miles.
Rate per party field day, 2 miles.
Lines rejected, 6.
Lines reran, 34—equal to 8 per cent of total number.
Probable error of whole line in millimeters, per kilometer, 0.72.

WALTER P. STEWART, *Junior Engineer.*

[Letter of the Terre Haute Chamber of Commerce.]

TERRE HAUTE CHAMBER OF COMMERCE,
Terre Haute, Ind., April 15, 1914.

DEAR SIR: Replying to your request for data respecting commerce along the Wabash River, herewith submit the following:

Freight rates, fourth and fifth classes, from Terre Haute, Ind., to points named below, by rail, are as follows:

To—	Fourth class.	Fifth class.
Louisville, Ky	15.5	12.5
Cincinnati, Ohio	14.5	11.5
Pittsburgh, Pa	21	18
St. Louis, Mo	14.5	11.5
Evansville, Ind	12.5	9.5
Memphis, Tenn	39	34
New Orleans, La	54	44
Kansas City, Mo	38	32

Rates to Louisville, Cincinnati, Pittsburgh, St. Louis, and Evansville are governed by official classification. Rates to Memphis and New Orleans are gov-

erned by southern classification, while rates to Kansas City are governed by western classification.

Everything shipped out of Terre Haute may be classified as heavy freight, comprising as it does such articles as merchant iron, malleable castings, steel castings, gray iron castings, brass castings, automobile parts, building brick, paving brick, beer, boilers, bottles of all kinds, canned goods of all kinds, cement blocks, coal-mining machinery, concrete building-block machinery, dies, dynamos, electrical machinery, engines, enameled ware, feed, fencing, flour, galvanized-iron products, gasoline engines, handles for tools, hominy, ice, mineral waters, oils, paper, meat packing-house products, sewer pipe, drain tile, stokers, scales, structural iron, building tile, wheels of all kinds, whisky, coal, etc.

The quantity of heavy freight shipped out of Terre Haute for the year 1912, exclusive of coal, was approximately 1,780,608 tons. The coal shipments from Terre Haute under normal conditions will run from 1,200 to 1,500 carloads per day. These figures do not include through cars interchanged with railroad connections. The inbound tonnage handled by the various railroads of Terre Haute for the year 1912 was approximately 2,376,789 tons. The heavy freight shipped from this city goes in all directions and is pretty equally divided in the distribution to the four points of the compass.

The inbound heavy shipments come from the North, East, and South. The rolling mills ship iron in considerable quantities to the South. At the present time very rich iron-ore deposits are being developed in the southeastern part of Missouri in the neighborhood of Cairo, Ill., which could be brought to the coal fields of Indiana for manufacturing purposes if adequate means for transportation at reasonable rates were provided. Large quantities of grain of various kinds are also shipped in here from the South. Freight rates on these articles are proportionate with the rates quoted above.

The county roads of Vigo are in fairly good condition, more attention being given to improvement of this kind each succeeding year.

Our city has no public wharf, but there is one on the river to which access has always been given. An effort is now being made to purchase this and it will be successful.

At the present time there is no freight carried by boat to or from this city. The river is not in boating condition, consequently there is very little boating. This should not be considered an argument against the improvement of the Wabash River, however, from our standpoint. From Terre Haute to the mouth of the Wabash River it flows through five counties in Indiana and eight counties in Illinois. The Indiana counties follow and produce annually the following crops in bushels:

Counties.	Corn.	Oats.	Rye.	Wheat.
Vigo	1,750,000	307,000	37,000	447,000
Sullivan	2,178,000	362,000	1,230	388,000
Knox	3,452,000	156,000	2,200	886,000
Gibson	2,326,000	92,000	1,500	1,185,000
Posey	2,214,000	42,000	430	1,272,000
	11,920,000	959,000	42,360	4,178,000

The Illinois counties follow and produce annually the crops set forth, in bushels:

Counties.	Corn.	Oats.	Rye.	Wheat.
Clark	2,293,000	653,000	7,800	247,000
Crawford	1,785,000	334,000	640	450,000
Lawrence	1,747,000	183,000	400	469,000
Wabash	1,041,000	132,000	140	380,000
Edwards	817,000	171,000	200	189,000
White	2,621,000	132,000	1,100	1,002,000
Gallatin	1,521,000	38,000	400	570,000
	11,825,000	1,643,000	10,680	3,307,000

In Indiana running north and south there is practically but one railroad which connects the Wabash River counties with Terre Haute, and the same

statement applies with equal force to the Wabash River counties in the neighborhood, State of Illinois. Next to Peoria, Ill., Terre Haute is probably the largest distilling point in the United States. It also has a hominy mill which consumes 16,000 bushels of corn every 24 hours throughout the year. It has a grain elevator with a capacity of 1,000,000 bushels, and in addition to these it has a number of other corn-consuming plants It is the natural market for nearly all the corn raised in the Wabash River counties of the States of Indiana and Illinois, and with a navigable river not only the corn but the other grain and farm products raised in the counties named would find a ready market in Terre Haute.

The value annually of the products of the Wabash River counties south of Terre Haute are as follows:

	Farm products.	Manufactured products.	Total.
Gibson County, Ind	.....	.....	$4,265,715
Knox County, Ind	.....	.....	5,229,064
Sullivan County, Ind	.....	.....	2,367,100
Vigo County, Ind	$1,642,242	$28,385,050	30,027,292
Clark County, Ill	1,968,096	503,637	2,471,100
Crawford County, Ill	1,513,507	301,820	1,815,327
Gallatin County, Ill	1,037,895	457,468	1,495,363
Hardin County, Ill	334,541	84,314	418,855
Lawrence County, Ill	1,388,016	317,929	1,705,945
Pope County, Ill	710,846	198,553	909,381
Wabash County, Ill	842,867	352,592	1,195,459
White County, Ill	1,963,150	490,756	2,453,906
Total	11,401,160	31,092,101	54,355,140

The value of steam railroads in the five Indiana counties on the Wabash River south of Terre Haute is in the neighborhood of $8,000,000, and electric railroads in the neighborhood of $450,000; assets vary. Statistics are not at hand for Illinois counties, so they can not be given in this connection.

The manufacturing establishments of the cities on the Wabash River from Terre Haute south, together with the number, capital, and value of products, is given as follows:

Cities.	Number.	Capital.	Value of products.
Mount Vernon, Ind	86	$713,217	$1,382,349
Princeton, Ind	87	605,351	929,270
Terre Haute, Ind	429	8,938,107	27,784,619
Vincennes, Ind	109	1,552,386	2,282,384
Carmi, Ill	35	115,166	169,171
Mount Carmel, Ill	52	249,527	285,066
	798	12,173,754	32,832,859

By counties the manufacturing establishments of the Wabash River from Terre Haute south are given as follows:

	Number.	Capital.	Value of products.
Gibson County, Ind	199	$1,078,468	$2,118,983
Knox County, Ind	189	1,844,281	2,787,822
Posey County, Ind	164	934,858	1,791,586
Sullivan County, Ind	128	329,686	595,692
Vigo County, Ind	473	9,262,259	28,385,050
Clark County, Ill	125	281,385	504,637
Crawford County, Ill	83	157,366	501,820
Gallatin County, Ill	54	314,684	457,468
Hardin County, Ill	21	38,987	84,314
Lawrence County, Ill	68	153,482	317,929
Pope County, Ill	53	94,291	198,535
Wabash County, Ill	67	290,537	352,592
White County, Ill	97	327,008	490,756
Total	1,721	15,107,394	38,386,184

The natural resources of this neighborhood which would be developed by the river improvement are our shale and clay products and our coal. The shale and clay deposits of their neighborhood are practically inexhaustible and are capable of producing the best of everything in that line. Paving brick made here was used on the Isthmus of Panama. These brick were shipped from Terre Haute to New York and from New York to Panama by water. With a navigable river they could be sent direct to New Orleans, and from there to the Isthmus. These, together with building brick, sewer brick, drain tile, and hollow building blocks, would find a ready market, provided the river were navigable at all points between this and the mouth of the Mississippi River. Some of the finest clay plants in the United States are located in Terre Haute. Probably the greatest asset which the State of Indiana possesses is its coal. The counties bordering on the river from Terre Haute south have a coal area of 1,800 square miles, with a total estimated tonnage of workable coal of 6,804,600,000 tons, which is being mined at the rate of 2,285,000 tons, valued at $1,517,250 annually. Much of this coal would find a market in the South along the river if there were any means of reaching those towns.

The Wabash Valley is one of the largest producing districts in the United States, its annual receipts amounting to nearly $19,000,000, of which 90 per cent is paid by the two towns of Terre Haute and Vincennes.

At all points in the United States where the railroads come in competition with navigable waterways freight rates are lower in proportion than they are at points where there is no waterway competition. This being the case, a navigable Wabash River would tend to keep freight rates on a lower basis, and would likewise produce better service. The country needs all the means of transportation which can be made available. The railroads in most cases have more freight than they are able to handle, and it is impossible to secure quick service or through shipments. With river transportation through freight would go to its destination without changes from one road to another and without sidetracking.

A navigable Wabash River would open up to this region a southern trade which it does not now possess; it would also afford it easy access to the lumber district of the South, from which nearly all our supply at present comes.

The figures which are given in these statistics are rather old, being taken from census report of 1900 and succeeding years, and would make a much better showing were the later statistics available.

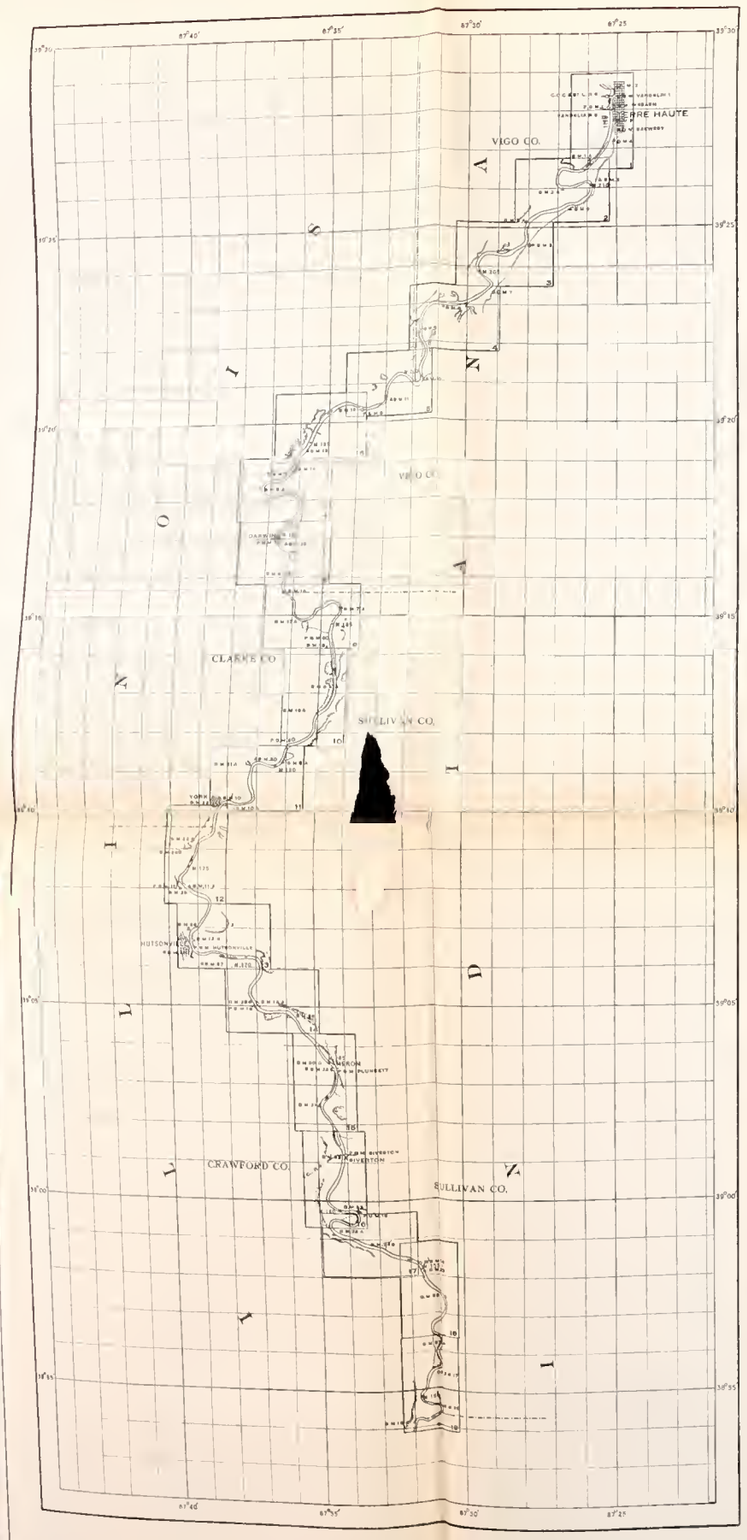
Very truly, yours,

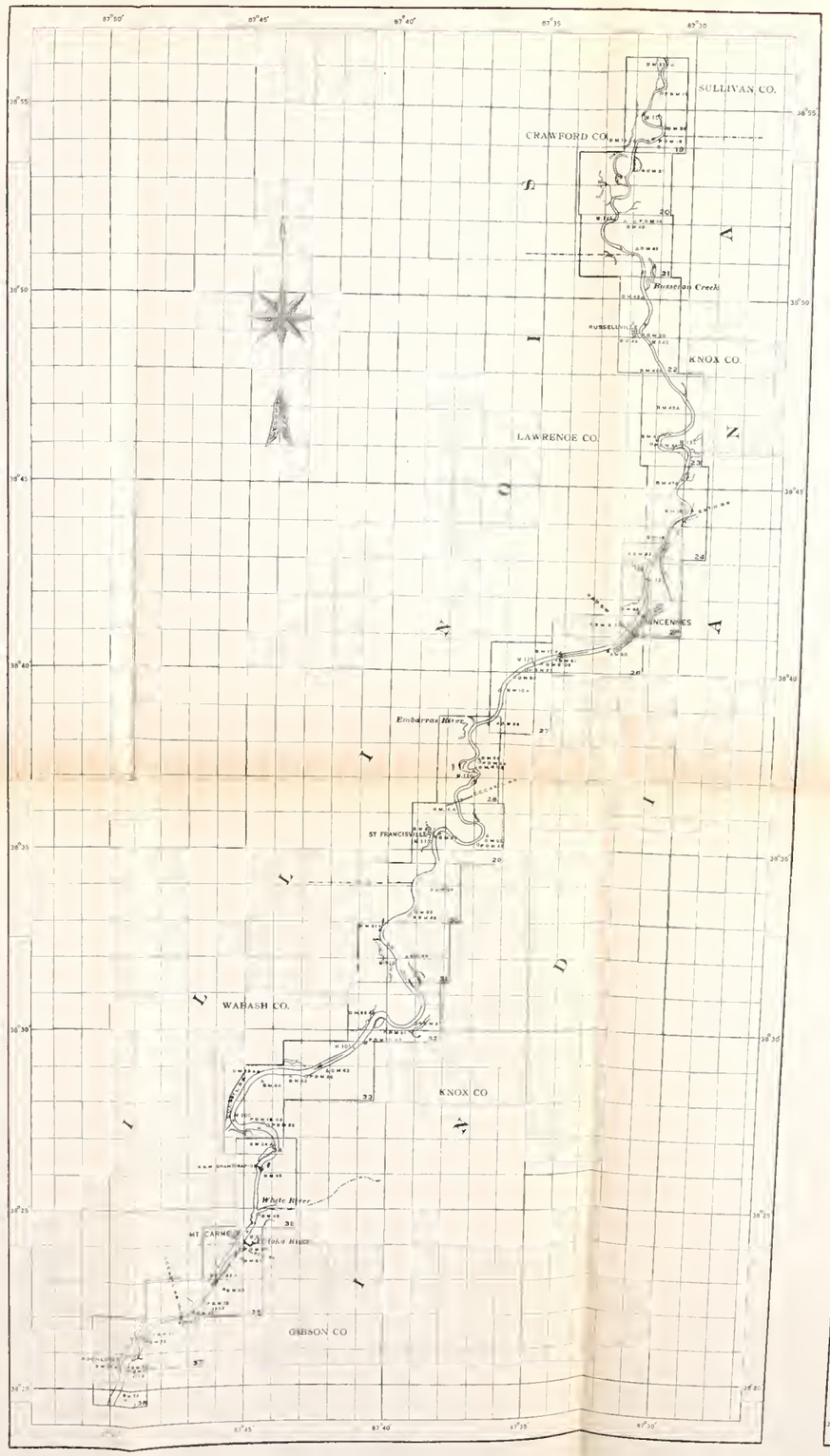
TERRE HAUTE CHAMBER OF COMMERCE,
By SPENCER F. BALL, *President.*

Hon. RALPH W. MOSS,
House of Representatives, Washington, D. C.

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY





INDEX MAP

WABASH RIVER

FROM

TERRE HAUTE, IND., TO MOUTH.

IN 64 CHARTS

SURVEYED AND MAPPED UNDER THE DIRECTION OF

THE DISTRICT ENGINEER OFFICER,

LOUISVILLE, KY.

BY

GEO. H. WOLBRECHT, ASSISTANT ENGINEER

1913.

SCALE MILES

1 ½ 0 1 2 3 4 5 MILES

House Doc. No. 1001; 63d Cong., 2d Sess.